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THE EFFECT OF ANTERIOR PITUITARY GROWTH HORMONE UPON THE COMPOSITION OF GROWTH.[1]

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Certain extracts of the anterior pituitary body are now well known to produce unusual growth when administered to experimental animals and to human pituitary dwarfs. The physiologic or metabolic mechanisms through which these effects are produced are not yet known, however. In the experimental work described here the growth responses and the composition of the gains in weight were determined in rats treated with the hormone and maintained upon a limited food allowance.

Twelve groups of animals, each composed of litter-mates of the same sex, and initial body weight and length were used. One rat of each group became a control, a second received growth hormone and a third mate was killed and analyzed at the beginning of the experimental period. The control and its treated mate were fed daily the same amounts of food, according to the so-called "paired-feeding" technic developed by Mitchell.[2] The period of paired feeding and treatment ranged from eight to eleven weeks at the end of which the rats were killed by pairs and analyzed for water, fat, nitrogen and ash.

The anterior lobe extract used was prepared from fresh beef pituitary glands, purified and assayed. The amount injected daily was somewhat less than that necessary to cause a maximal growth response.

After treatment began the animals receiving the hormone immediately passed their control mates in weight and continued to show an excess gain each week until killed. The twelve

[1]Summary of paper presented before the Ohio Academy of Science, April 14, 1933, as part of a Symposium on Endocrinology.

[2]Mitchell, H H and J R Beadles J. Nutrition, 2 225. 1930

controls weighed 2,382 grams initially and gained 764 grams; their twelve treated mates weighed 2,358 grams initially and gained 1,295 grams. The treated animals, on the same food consumption as their controls thus showed an excess gain of 531 grams, equivalent to the weight of two extra adult animals. Individually, eleven of the twelve treated rats showed an excess gain, a result which would be expected to occur by chance, only once in 340 times. The treated animals also showed significant excess gains in body length By the technic of paired-feeding the amount of food given daily to the two members of any pair was determined by the appetite of the less hurgry member. In only 91 of 763 daily instances was a control rat more hungry than its treated mate.

The initial composition of both groups of animals estimated from the analyses of their litter mates, was: water, 62 0 per cent; fat, 12 7 per cent; nitrogen, 3 3 per cent, ash, 4 3 per cent; and energy, 2.33 calories per gram The final composition of the controls was: water, 58 0 per cent; fat, 19 1 per cent; nitrogen, 3 0 per cent, ash, 4 0 per cent; energy, 2.83 calories per gram The final composition of the treated animals was. water, 62.5 per cent, fat, 12 9 per cent; nitrogen, 3.2 per cent; ash, 4 1 per cent; energy, 2 32 calories per gram The controls showed the characteristic changes in body composition with age that would be expected. These changes were statistically significant decreases in the proportions of water, nitrogen, ash and fat-ash-free dry tissue, and increases in the percentage of fat and in the heat value of the carcass The treated animals, on the other hand, retained almost exactly their initial composition in all constituents and in the heat value of their tissues. Their gains in weight were consequently also closely similar to their carcass composition initially The composition of the gains in weight, and of the excess gains by the treated rats is given in the accompanying table.

Statistical analysis of the data by Fisher's[3] measure of the significance of the difference in the means of small samples supports the inference that nitrogen and fat-ash-free dry tissue (protein) were the constituents most specifically affected by the hormone.

The nitrogen, ash and energy balances were determined in each group of animals, both directly from carcass analysis and

[3] Fisher, R. A. Statistical Methods for Research Workers. 3rd Ed , London, 1930.

indirectly from the intake and excretion. The excess retention for the whole period by the treated rats over their controls was 22.5 grams of nitrogen and 22.4 grams of ash. The excess nitrogen retention by weeks closely paralleled the weekly excess gain in weight. The energy balance was slightly in favor of the controls, as they retained 341 calories (0.8 per cent of the total intake), more than their treated mates, despite the fact that their weight gain was some 500 grams less. The energy require-

TABLE I

SUMMARY OF GAINS AND COMPOSITION OF GAINS IN CONTROL AND TREATED ANIMALS

Group	Body Length Cm	Live Body Weight Gm	Empty Carcass Weight Gm	Composition of Empty Carcass Gain Grams and Per Cent					Energy Calories
				Water	Ether Ext	Fat-free Dry Tissue	Total N.	Ash	
CONTROLS—									
Total Gain	18.2	764	716	324	281	111	15.4	22.7	3161
Percent of Gain in Empty Carcass Weight				45.2	39.3	15.5	2.15	3.16	4.41*
Percent of Initial Datum	7.4	32.1	31.3	22.8	96.7	19.2	20.7	23.1	59.3
TREATED—									
Total Gain	33.1	1295	1217	771	162	284	37.9	45.1	2820
Percent of Gain in Empty Carcass Weight				63.3	13.3	23.4	3.12	3.71	2.32*
Percent of Initial Datum	13.5	54.9	53.7	54.0	56.3	49.0	51.5	46.4	53.5
EXCESS GAIN OF TREATED	14.9	531	501	447	119	173	22.5	22.4	341
Percent of Excess Empty Carcass Weight				89.2	—23.8	34.5	4.49	4.47	−0.68*

Empty carcass is the carcass minus the contents of the alimentary tract
*Calories per gram of empty carcass weight

ments for muscular activity were somewhat greater in the treated, but their energy expenditure per gram of weight gained was considerably less than that of the controls

It is concluded that although the amount of the food consumption may be a limiting factor for growth under certain conditions, the growth hormone through its influence upon metabolic processes, is able to affect growth independently of the food intake. The growth produced has the same characteristics as the growth exhibited by young animals—a marked retention of nitrogen, synthesis and deposition of protein and a relatively high content of water and low content of fat.

FUNCTIONS OF THE ADRENAL CORTEX.[1]

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Recent work carried out in our own and other laboratories has indicated certain functions of the adrenal cortex. We propose to briefly review some of these functions.

It has been known for over three-quarters of a century that the adrenal glands are essential for life; but not until 1916 did Wheeler and Vincent demonstrate that it was the cortex of these glands which was so vital.

ADDISON'S DISEASE

The first really important contribution to the understanding of the function of the adrenal was the work of Thomas Addison, an English physician, who described the effects of disease in these organs. We now know that an absence of certain functions on the part of the cortex is responsible for these changes. Let us examine the picture from the earliest symptoms to the extreme prostration in late disease.

Asthenia.—Asthenia is the first to appear. This is so insidious that the patient may be unable to date its first appearance. He recognizes it only as an inability to perform accustomed tasks without fatigue, a condition which might be accounted for in many ways. Therefore, until the disease becomes farther advanced, it is usually ignored.

The asthenia involves the nervous system as indicated by the easy fatigue of the mental processes and the intolerance to stimuli. In the later stages general debility reduces activity to a minimum and a profound inertia develops, finally ending in prostration or coma. Other evidences of the involvement of the nervous system are insomnia, mental depression, failure of memory, poor judgment, lack of co-operation. Later there may be heightened motor activity and finally twitching and convulsions. If one administers an extract containing cortin, the vital hormone of the adrenal cortex, a patient in the late stages of Addison's disease responds with a disappearance of

[1]Presented before the Ohio Academy of Science, April 14, 1933, as part of a Symposium on Endocrinology

the symptoms in the reverse order. Coma is replaced by increased motor activity, twitching and marked myotatic response to stimuli. With the return of consciousness, there may be disorientation, mental irritability and lack of co-operation. Later a state of calm is reached in which the heightened irritability disappears, pain is relieved and the patient becomes more rational and sleeps much. Finally the stage of recovery is reached in which mental alertness returns and asthenia is reduced. The patient sleeps well and not abnormally long as before. He becomes co-operative and takes an interest in his surroundings. These improvements begin to appear usually within a few hours after injections start, and recovery is reached within two or three days.

Experiments with animals have proven conclusively the widespread involvement of the nervous system in the asthenia of cortin insufficiency. By using a reflex preparation of the rat, we have been able to show that cortin will prevent to a large extent the fatigue which develops after the removal of the adrenal glands. This fatigue or asthenia is found in the reflexes, the myoneural junction and the muscle.

The subjective evidence from patients, as already stated, indicated that cortin played a role in the function of the higher centers. Anderson, Liddell and Hartman have shown objectively that cortin can influence the higher centers They found that sheep made neurotic by attempting to develop a fine discrimination in the conditioned reflexes were improved by the injection of cortin. Under its influence, spontaneous movement almost disappeared while the response to the conditioned stimulus more nearly approached the magnitude of that in normal sheep.

Hartman, Beck and Thorn have shown that cortin has a pharmacological effect on the nervous system Cases in which fatigue was the outstanding complaint have sometimes shown improvement in the nervous symptoms with cortin injections. Mental irritability was decreased, sleep improved and resistance to fatigue, both mental and muscular, was increased.

Cortin affects the nervous system in a normal individual under certain conditions; namely, when he is below par from over-work or from an infection. Improvement may be reflected in better sleep, and an increased sense of well-being sometimes to the point of euphoria. There is no proof, however, that in these subjects there was a cortin insufficiency. It might be

explained as a pharmacological action—merely the effect of added cortin to that normally poured into the blood stream.

As already stated, muscle as well as the nervous system is involved in the asthenia of cortical insufficiency. A number of workers have observed that the metabolic activity of the muscle itself is greatly reduced.

Asthenia also involves the circulatory system. According to many authorities, however, this is not the first system to be affected In the later stages the heart action may be feeble. This may be similar in origin to the weakness found in muscle. The blood vessels themselves may be at fault. The poor compensation to change in posture indicates as much A subject in advanced Addison's disease not only may have a blood pressure lower than normal but when he changes from a reclining to a sitting or standing position the pressure may fall. This may be due to failure of the reflex mechanism In the later stages, the fluid may be lost to the tissues and the blood may become concentrated. A number of workers as far back as 1927 have suggested that the function of the adrenal was to regulate the proportion of plasma Viale and Bruno attributed the increase of permeability to the nervous system and to changes in the composition of the blood We have found that removal of the adrenals causes an increase in the water content of many of the tissues, such as skin and liver. When adrenalectomized animals are exposed to heat, water shifts less readily from the reservoirs into the blood Such animals suffer from heat more readily than animals treated with cortin.

Kidney—The kidney becomes involved in adrenal insufficiency. In the late stages particularly this is true, and it seems to appear before the blood pressure is sufficiently low to account for the reduced function. In late stages of adrenal insufficiency the blood urea may become quite high.

Gastrointestinal instability—Gastrointestinal instability is an outstanding symptom of Addison's disease. In some patients, it may occur quite early; in others, later This may be accounted for in part by changes in the nervous system. In the later stages the circulation may be a factor Not only the more sluggish circulation associated with hypotension but hemorrhages and ulcers which develop indicate as much. Cortin stops the nausea and vomiting, and brings about recovery of appetite It likewise stops the hemorrhages which sometimes occur from the alimentary canal in late insufficiency in animals.

You perhaps begin to realize that the vital hormone seems to be essential for all the tissues.

Metabolism.—It was shown in 1922 by Aub, Forman, and Bright that removal of both adrenals in an animal reduced the metabolism In 1928 we were able to show that metabolism could be maintained within normal limits with small amounts of cortin. On the other hand, it has been impossible to raise the metabolism above normal either in animals or in normal human beings by the injection of large amounts of cortin

Effect of cold—The need for cortin under stress is very well demonstrated on exposure to cold. Adrenalectomized rats divided into two groups, one injected with salt solution and the other with cortin, at first show no difference on exposure to cold, but very soon the animals without cortin begin to be seriously effected. A study of the heat production has shown us that although both those treated with cortin and those only injected with saline at first produce the extra heat required, later those without cortin are not only unable to produce the extra heat required, but they produce less than they did normally at ordinary temperatures Thus, we find a marked fall in their body temperature and some of them even die The failure to produce the heat may be accounted for by the fatigue of the reflexes which are involved in response to cold, and the failure of the muscle itself to carry on the increased activity in the long run

Growth.—Cortin is essential for growth whether it be the natural development of young animals or the renewal of tissue in the healing of wounds In adrenal insufficiency growth or the healing of wounds may stop Upon the administration of adequate amounts of cortin, growth is resumed.

Resistance to toxins.—In adrenal insufficiency there is a lowered resistance to various toxins That resistance can be raised by the injection of cortin

RELATION TO VITAMINS.

Cortin appears to bear some relation to the utilization of vitamins B_1 and C The use of extracts containing cortin was suggested by the well-known changes which occur in the cortex of the adrenal gland in deficiencies of these vitamins. These changes indicated a possibility of extra demand on the gland. When an extract containing cortin was given to guinea pigs on vitamin C deficient diets the onset of scurvy was delayed.

The extract was prepared in such a way that none of the vitamin which itself prevents scurvy could have been present. Injection of this extract also delayed the onset of nervous symptoms due to a deficiency of vitamin B_1 in the diet.

CHEMICAL CHANGES.

The various chemical changes which appear in adrenal insufficiency have been followed by different investigators with an attempt to find a change which is a key to the disturbance in function without success. The evidence seems to accumulate that cortin is a general tissue hormone.

CORTILACTIN.

We have been able to separate from cortical extract a substance which is necessary for lactation. Adrenalectomized mother rats treated with amounts of cortin much more adequate than that required to maintain weight and health does not enable them to raise litters of young. A second substance must be added. Young rats nursed by adrenalectomized mothers receiving only cortin begin to die off a few days after birth, with 10 per cent or less reaching the stage of weaning. Adrenalectomized mothers, however, furnished with this new hormone in addition to cortin are able to raise a considerable portion of their litters. This new hormone which is essential for lactation has been named cortilactin.

We may say in conclusion that there is now positive evidence that the adrenal cortex produces two hormones: one, cortin, the vital hormone which seems to serve as a general tissue hormone; and, two, cortilactin, which is necessary for milk production

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Psychology, Genetics, and Intelligence.

This volume is an attempt to gather within a single cover the voluminous material on mental testing, and the relation of intelligence to its twin causes, heredity and environment The book appears to be a very complete summary of the literature, including a considerable number of references with which the casual student would be unfamiliar, and some which even the specialist might readily have missed. The most valuable inclusions in the book, however, are the critical comments on the abstracted material, which are keenly analytical and are constructively presented. No more timely book in the field of human biology could well be imagined —L. H S.

Heredity and Environment, by Gladys C. Schwesinger. ix+484 pp. New York, The Macmillan Company, 1933.

THE DISTRIBUTION OF CUTIN IN THE OUTER EPIDERMAL WALL OF CLIVIA NOBILIS.

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Epidermal cell walls are commonly considered by botanists as cellulose membranes upon which more or less cutin has been deposited. On the evidence of earlier microchemical work three general regions or zones in epidermal walls are recognized· a thin outer layer of cutin (the cuticle), an inner zone of cellulose and an intermediate zone containing both cutin and cellulose

The inadequacy of this conception has been demonstrated in brilliant fashion by Frey-Wyssling (2). By studying the effect of the wall upon polarized light Frey-Wyssling has revealed a complexity of structure in certain epidermal walls that was entirely unsuspected. The outer epidermal walls of petioles of *Acuba japonica* were shown to possess curiously isolated plates of cutinized cellulose over each cell. The outer epidermal wall of leaves of *Clivia nobilis* were shown to possess marked differences in double refraction at different levels and a definite zone of isotropic material near the center of the wall, (Fig. 1A)

These researches of Frey led to a further examination of the detailed structure of these epidermal walls from a microchemical point of view. In the case of *Clivia*, the writer (1) was able to detect the presence of three membrane constituents in the wall—cellulose, cutin and pectic materials The structural relationships between these three membrane constituents is outlined in Fig. 1B The decrease of double refraction in the cellulose layer Z was related to an increase in amount of colloidal pectic material. The isotropic zone P was caused by the dominance of colloidal pectic material which reached its maximum in this zone. The rapid increase in double refraction as the outer portions of the wall were approached was explained by the decrease in abundance of pectic material in the wall. The maximum double refraction was reached at about the center of the zone of cutinized cellulose and at this point the pectic material reached a minimum. The decrease in double refraction as the cuticle was approached resulted from the steady decrease in the amount of cellulose present until finally when the cuticle C was reached cellulose was no longer present and the wall

became isotropic. The results of the microchemical investigations of this wall suggested an interpretation of the optical results. The two lines of investigation supplemented each other nicely and the results suggest the importance of using both lines of attack in cell wall work.

During the past summer an interesting modification of this epidermal wall was discovered in the leaves of a plant (Clivia) growing in the greenhouse of the Department of Botany of

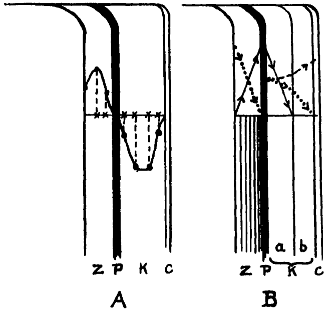

FIG 1. Diagrammatic representation of the birefringence and chemical relationships in the outer epidermal wall of *Clivia nobilis*

A. Diagram of the variation in double refraction at different levels in the wall (after Frey) Z represents the cellulose portion adjacent to the cell lumen Its double refraction reaches a maximum at the center of the layer and drops rapidly as the isotropic zone P is approached K represents the cutinized cellulose and is optically negative Double refraction reaches a maximum at the center of the zone and falls rapidly as the outermost layer, C, the cuticle, is approached

B Diagram of the relationships of cellulose, pectic material and cutin in the same wall (after Anderson) The cellulose layer Z contains both pectic material and cellulose, the former increasing in amount as the isotropic zone is approached and the latter decreasing The isotropic zone P contains pectic material with little or no cellulose. The cutinized cellulose K is divided into two zones, one of which (a) contains cellulose, pectic materials and cutin Pectic materials decrease in amount, cutin increases in amount and cellulose decreases slightly as the zone (b) is approached Zone (b) contains only cutin and cellulose with the latter decreasing in abundance as the cuticle is approached The cuticle, C, contains cutin only

The Ohio State University Certain leaves of the plant showed a remarkable secondary cutinization of the inner portion of the wall that is apparently unique in epidermal walls This unusual development is not characteristic of Clivia plants in general yet since it is not only an interesting phenomenon but one that may have an important bearing upon ideas regarding the mechanism of cutinization, the wall was given further study. This paper reports the results of a microchemical investigation of this epidermal cell wall.

METHODS

Living leaves from the Clivia plant were cut with a sliding microtome into sections 8 or 10 microns in thickness Similar sections were prepared from leaves preserved in 95% alcohol. These sections were subjected to the usual microchemical tests for membrane substances Tests of three types were employed, (a) differential staining reactions, (b) differential solubility reactions, and (c) polarized light The polarizing microscope alone permits the use of three different methods of determining the distribution of certain membrane constituents Some membrane substances exhibit double refraction while others are isotropic (Plate I, Fig 7) Insertion of a gypsum plate Red 1 between the nicols permits the use of interference colors to distinguish between some membrane compounds (Plate I, Fig. 8). Advantage may also be taken of dichroism in studing the distribution of lignin or cutin in cellulose membranes

The various methods serve to check each other Differential staining is not thoroughly reliable in all cases but is a valuable indicator of the presence or absence of specific materials. Results were not considered conclusive unless indicated independently by each line of attack The following table gives a brief summary of the principal tests used in this study

CELLULOSE.

- Deep blue color with I_2KI and 65% H_2SO_4.
- Blue violet color with chlorzinc iodide.
- Unstained with methyl green unless combined with cutin and pectic compounds.
- Unstained with Magdala red (echt) unless combined with cutin and pectic compounds.
- Unstained with Ruthenium red unless combined with pectic materials.
- Soluble in copper oxide ammonia.
- Soluble in 50% chromic acid.

Insoluble in hot dilute mineral acids.
Optically positive.
Optically anisotropic.

PECTIC COMPOUNDS.
Deep red color with dilute alkaline Ruthenium red.
Deep blue—blue violet with dilute Methylene blue.
Brown or in some cases colorless with chlorzinc iodide.
Unstained with Methyl green unless combined with cutin and cellulose.
Unstained with Magdala red (echt) unless combined with cutin and cellulose.
Insoluble in copper oxide ammonia.
Soluble in hot dilute mineral acids followed by hot dilute ammonia.
Soluble in 50% chromic acid.
Optically isotropic.

CUTIN.
Red color with Sudan III.
Red color with Scharlack R.
Violet stain with Methyl green when combined with cellulose and pectic materials.
Colorless with Methyl green when free from cellulose and pectic materials.
Red color with Magdala red (echt) when combined with cellulose and pectic compounds.
Colorless with Magdala red (echt) when free from cellulose and pectic compounds
Brown color with chlorzinc iodide.
Insoluble in 50% chromic acid, copper oxide ammonia, and hot dilute mineral acids.
Saponified with hot concentrated KOH.
Optically negative when combined with cellulose
Optically anisotropic when combined with cellulose.
Optically anisotropic or optically isotropic when free from cellulose.

Mention should be made of the importance of Methyl Green and Magdala Red introduced by Kisser (4) as a means of detecting cutinized cellulose. Methyl Green commonly contains small quantities of Methyl Violet as an impurity. This Methyl Violet is strongly absorbed by cutinized cellulose containing pectic compounds from dilute solutions of Methyl Green. Beautiful results may be obtained with the dye if properly used and it can be most instructive in determining the presence of combinations of the three membrane constituents mentioned. The intensity of the stain seems proportional to the abundance of cellulose and pectic materials. Magdala Red works equally well, giving a distinct red color that sharply differentiates the different regions in the wall.

These dyes are also helpful in studying lignification as Kisser has pointed out.

Through the courtesy of Professor W. Seifriz the writer was able to examine preparations of the wall with the Spierer lens. The image gave the characteristic striated appearance reported by Seifriz (6) and others in the cellulose and outer cutinized portions of the wall. The inner zone of cutinized cellulose presented an entirely different aspect. In place of the symmetrically arranged striations the dark rods were chaotically distributed, giving the appearance of much folding and irregularity of arrangement. This indicated a different physical relationship in the inner zone of cutinized cellulose over that prevailing in the outer portions of the wall.

In addition to the interference colors obtained with a gypsum plate Red I, the polarizing microscope permits the use of dichroism as a tool in cell wall work. Ambronn discovered this phenomenon in 1888 but it was the work of Frey-Wyssling (3) that has demonstrated the importance of the phenomenon in cell wall work. Dichroism is apparently the result of the micellar structure of the cellulose wall. When a bast fiber of flax (Linum) is stained with chlorzinc iodide and examined with a polarizing microscope, using the polarizer only, the color of the fiber varies from almost black to colorless when the stage is rotated. The following quotation from Frey-Wyssling indicates the way in which this phenomenon may be utilized in studying the distribution of cutin in epidermal walls:

"Die gelben Reaktionen von Lignin, Suberin und Kutin sind im Gegensatz zur Zellulosereaktion nicht dichroitisch. Frisch gefärbte Schnitte von Holz- und Korkgeweben, sowie stark kutinisierte Epidermen (z. B. von *Clivia nobilis*) weisen keine Intensitätsunterschiede auf, wenn man den Objekttisch über dem Polarisator dreht.

"Diese Feststellung ist wichtig; denn sie gestattet uns den Nachweis von Lignin und Kutin in nur schwach imprägnierten Zellmembranen, die mit vielen Reagentien nur Zellulosereaktionen geben. Färbt man solche Objekte, wie z. B. Jutefasern oder die langen Haare des Fruchtschnabels *Erodium gruinum*, mit Chlorzinkjod und bringt sie über dem Polarisator in die Stellung 'farblos,' so erscheinen sie je nach dem Ligningehalt schwächer oder stärker gelb gefärbt.

"So erlaubt uns das Chlorzinkjod nicht nur völlig verholzte und kutinisierte Membranen zu erkennen, sondern mit Hilfe

des Dichroismus der Zellulosereaktion können in der Stellung des Absorptionsminimums selbst die ersten Anfänge der chemischen Zellwandveränderungen, die oft schwer nachzuweisen sind, spielend enthüllt werden."

All of the above mentioned methods have been used in studying this epidermal wall—and results from the various methods are in agreement.

RESULTS.

Staining the wall with Sudan III brings out clearly the two distinct zones of cutinization (Plate I, Fig 1). The outer zone and the inner zone of the cutinized wall are distinctly separated by a colorless zone of cellulose and pectic material. The structure of this deposit has been reported in an earlier paper (1). In some cases the inner cutinized zone is adjacent to the protoplasm of the epidermal cell while in other cases a second zone of cellulose separates the protoplast from the inner zone of the cutinized wall Both conditions may be seen in the figure cited. Careful staining with dilute Sudan III reveals a difference in intensity of stain in the outer portion of the wall The same effect may be produced by staining with Sudan III and then carefully washing out the stain with alcohol The vertical boundary line between each cell is emphasized by a deeply staining, vertical, rod-shaped region (Plate I, Fig. 2). This zone differs decidedly from the rest of the cutinized wall in its higher content of cutin, and in the ease with which it may be saponified The cellulose in the outer wall is not continuous, but grouped in a series of fine horizontal lamellae over each cell Between these groups of cellulose lamellae extends this narrow vertical partition of nearly pure cutin, partially isolating each cell from other cells in the outer wall This structure is clearly revealed when the wall is saponified with concentrated KOH (Plate I, Figs. 5 and 6) The presence of this vertical partition of cutin between the epidermal cells is further revealed in striking fashion by the polarizing microscope (Plate I, Figs. 7 and 8) The outermost layer of cutin, the cuticle, is more resistant to saponification and remains as a definite sheet-like layer when the cutin has been removed from the remaining portions of the wall with saponifying agents (Plate I, Figs. 5 and 6).

The presence of cutin in the inner cutinized zone is not only indicated by the adsorption of Sudan III, but also by the action

of concentrated chromic acid. This reagent quickly removes the cellulose but aside from a slight swelling that reveals a distinct lamellation, the inner zone of cutin is unaffected (Plate I, Fig 4). Apparently this inner cutinized zone consists of a group of parallel lamellae of cellulose, separated by pectic material and infiltrated with cutin Saponification of the cutin in this zone produces globules of soap as readily as the cutin present in the outer portion of the wall (Plate I, Fig 5). The lamellae that are visible after saponification give the recognized tests for cellulose. The inner zone shows the interference colors characteristic of cutinized cellulose, though the colors are less conspicuous than those of the outer portions of the wall (Plate I, Fig 8). The high pectic content of the inner cutinized zone is indicated by the intensity of the staining reactions (Magdala Red, Methyl Green), by the solubility reactions and by the marked decrease in double refraction of this portion of the wall (Plate I, Fig 7). The inner cutinized zone exhibits a slight but definite double refraction and gives the dichroism characteristic of cutinized cellulose when treated with chlorzinc iodide

DISCUSSION

The outer epidermal wall of the leaves of the *Clivia nobilis* plant studied, differs from the outer epidermal wall of most Clivia plants in having two definite zones of cutinized cellulose. The cellulose deposited by the protoplasm of the epidermal cell is unevenly distributed around the vacuole, being much thicker on the outer wall. This cellulose deposit is not homogeneous, but consists of a series of fine horizontal lamellae separated by colloidal pectic material The amount of pectic material varies in different portions of this outer wall and the present investigation confirms the structure reported in an earlier paper in this respect. This complex of cellulose and pectic lamellae is deposited only above each protoplast and does not extend continuously from cell to cell. The apparent continuity of the epidermal wall is due to the presence of cutin that impregnates the stratified deposition of each cell and fills the spaces between the cells, welding them into one wall. The outer epidermal wall is therefore essentially a mosaic of the cutinized cellulose of individual cells bound together by vertical partitions of cutin.

The inner zone of cutinized cellulose has in general the same

fundamental structure present in the outer portion of the wall. The deposit consists of a series of thin cellulose lamellae, separated by and impregnated with colloidal pectic material. To this has been added the cutin. The thickness of this inner cutinized zone varies widely in different cells of the same section and is in general thicker in the upper epidermis than in the lower. In some cells the deposit is apparently in direct contact with the living protoplast while in others it is separated from the protoplast by a second deposit of cellulose.

Concerning the cause for this unique deposit little can be said. It is not general and the author has not seen it in his earlier work with Clivia plants. It seems limited to relatively few individuals through an examination of the leaves of Clivia plants in various parts of the country may reveal that the habit is more general than realized at present. The deposit is of particular interest in regard to present theories of the mechanism of cutinization. Lee and Priestley (5) have suggested that the fatty constituents of epidermal walls may reach the epidermis by migration along the radial walls of the subepidermal tissues. On reaching the outer wall the fatty materials are condensed and oxidized forming the cutinized portions of the epidermal wall. The present study offers support to their suggestion that exposure to the light and air modifies considerably the character of the fatty deposits for the outermost layer is decidedly more resistant to saponification than are the deposits of cutin within the wall itself. It is difficult to account for this inner localized zone of cutin completely surrounded by cellulose, or at least bordered by cellulose on the *outer* margin on the assumption that the fatty constituents were migrating to the surface through the walls of the subepidermal cells and deposited in the walls through the loss of water.

In this case the epidermal wall seems to be produced by the epidermal cells themselves, and furthermore it indicates that the mechanism of cutinization may be more complex than generally realized at present. It is not impossible that the cutin partitions between the cutinized cellulose of each epidermal cell may arise from subepidermal tissue and reach the epidermis by a migration, and it may be that some of the cutin in the outer wall has a similar origin. The general structure of the wall and the presence of these peculiar localized zones of cutin in the wall do not support this suggestion. It seems probable that in this wall the cutin as well as the cellulose and pectic

materials are all the result of the activities of the epidermal cells alone.

The inner cutinized zone is usually characterized by the appearance of numerous fine granules of fatty material. The delicate cellulose lamellae seem at times to be strings upon which cutinized beads are strung The cutin does not have the smooth uniformity of that in the outer portions of the wall. These granules may be seen in Figs 1, 3, and 4 of the plate. The Spierer lens further indicates that the arrangement of the units composing the wall are not regular nor uniform in this inner cutinized zone. The significance of these fine granules is unknown. In some cases gaps and spaces are evident in the inner cutinized zone These may have resulted from sectioning but seem to indicate that this portion of the wall has less cohesion than other portions

A large part of the experimental work described in this paper was accomplished in the Plant Microchemical Laboratories of The Ohio State University and the author wishes to express his appreciation of the many courtesies extended to him by members of the Botany Department of that institution. The author further wishes to acknowledge his indebtedness to Professor Seifriz, of the University of Pennsylvania, for the opportunity of examining sections of this wall with the Spierer Lens and to thank Dozent Dr. Frey-Wyssling, of Zürich, for his courtesy in checking dichroic and interference phenomena of the wall.

SUMMARY.

1. The epidermal cell walls of the leaves of some *Clivia nobilis* plants show two distinct zones of cutinization.

2. The inner zone of cutinized wall consists of a series of cellulose lamellae separated by layers of pectic material, both of which are impregnated with cutin

3. The inner cutinized zone may be in direct contact with the protoplasm of the cell or may be separated from the protoplasm by a second zone of cellulose and pectic materials

4. The inner cutinized zone is separated from the outer cutinized zone by cellulose and pectic material The structure of this deposit has been reported in an earlier paper.

5. The cutin is not uniformly deposited in the outer cutinized zone, nor has it the same chemical and physical properties in all portions of the zone.

6. The outermost layer of the wall contains no cellulose

nor pectic material and is more resistant to saponification than other cutinized areas of the wall.

7. The cellulose and pectic material in the outer wall of each epidermal cell are separated from other cells by vertical partitions of cutin that contain little or no cellulose.

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EXPLANATION OF PLATE I.

(All figures refer to cross sections of epidermal cells of leaves of *Clivia nobilis*.)

Fig. 1. Wall stained with Sudan III. Cutinized regions black, cellulose and pectic materials free from cutin are white. 440×

Fig 2. Wall stained with Sudan III and partially destained with alcohol, showing vertical partitions of cutin between the outer wall of each cell. 440×.

Fig 3. Wall stained with Magdala Red (echt). Inner zone of cutin, pectic materials and cellulose stains, vertical cutin partitions revealed and accumulation of pectic material indicated at boundary between cellulose and outer zone of cutinized cellulose 440×.

Fig. 4. Wall treated with 50% Chromic acid. Cellulose largely removed. Inner zone of cutinized cellulose swollen to reveal lamellated structure. 440×.

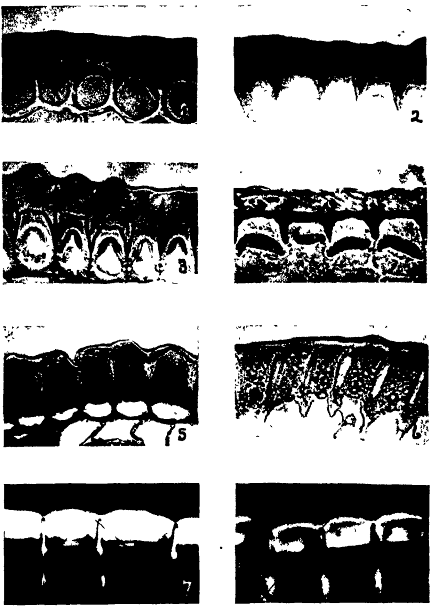
Fig. 5 Wall treated with hot conc. KOH, followed after washing, with Chlorzinc iodide. Resistant cuticle remains Vertical cutin partitions between cells removed, cellulose lamellae in outer walls stained blue Inner zone of cutinized cellulose showing lamellations and soap globules. 440×.

Fig 6. Wall treated with hot conc KOH Vertical partition of cutin completely removed. Soap globules apparent in zone of cutinized cellulose. Cuticle intact showing high resistance to saponification. Outer portion of wall only is shown. 440×.

Fig. 7. Wall as seen between crossed Nicols. Pectic zone in the wall appears as a black line. High pectic content of the inner cutinized zone markedly reduces its double refraction. 500×.

Fig. 8. Wall as seen between crossed Nicols with gypsum plate Red I inserted showing Interference colors. Vertical cutin partitions conspicuous. Inner cutinized zone optically negative indicating presence of cutin. 500×.

PLATE 1.



THE RED-BELLIED WATER SNAKE, NATRIX SIPEDON ERYTHROGASTER (FORSTER), IN OHIO.

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During a study of the reptiles indigenous to Ohio four water snakes of the genus *Natrix* have been collected. Three of these, *Natrix sipedon sipedon* (Linné), *Natrix septemvittata* (Say) and *Natrix kirtlandii* (Kennicott) are widely recognized and are known from numerous localities in the state. The fourth, a rarer, large, red-bellied form, has been identified as *Natrix sipedon erythrogaster* (Forster). There seems to be no general agreement among herpetologists as to the validity of the latter which has long been confused with *Natrix sipedon sipedon*. Stejneger and Barbour (1923, p 108) do not admit it to their "Check List of North American Amphibians and Reptiles," but refer to it in a footnote which reads, "Apparent forms which are more or less uniformly rufescent are found in the ranges of both the subspecies (*Natrix sipedon*) *fasciata* and (*Natrix sipedon*) *sipedon*. To these the names of *Natrix sipedon erythrogaster* and *Natrix sipedon fulviventer* have been given."[1] Blanchard in his key to North American snakes (1925a, pp. 9–10) includes *Natrix sipedon erythrogaster*, but mentions no locality as far north as Ohio In "The Herpetology of Michigan," by Ruthven, Thompson and Thompson (1912, p. 95) and Ruthven, Thompson and Gaige (1928, pp 105, 108) *erythrogaster* is not recognized as distinct, although Clark (1903, pp. 1–23) discussed in detail the differences between this form and *sipedon* as seen in a series of specimens from southern Michigan and concluded that it should be considered as a distinct species. Taylor (1929, p. 57–58), writing on the snakes of Kansas, favors a similar interpretation as does also Blanchard in papers (1922, p. 12, and 1924. pp. 537–538) published before the appearance of his key (1925a).

With a view to shedding some additional light on the systematic status, natural history and range of this reptile, in

[1]This foot note is repeated in the third (1933) edition of "A Check List of North American Amphibians and Reptiles," by Stejneger and Barbour.

so far as its occurrence in Ohio is concerned, the red-bellied water snake is here discussed in some detail. Young specimens obtained from captive females are briefly described and compared with the young of *Natrix sipedon sipedon*. A small series of *sipedon* from the same localities in which *erythrogaster* has been collected is considered for comparison as are also certain statistics gleaned from a study of 100 specimens of *sipedon* selected at random from various parts of the state.

While reported from other localities, *erythrogaster* has so far been taken in Ohio in only two places, these, with attendant data, being as follows.

1. Near Blakeslee, Williams County, (60 miles west of Toledo), 11 adult specimens of *erythrogaster*, one adult and one juvenile specimen of *sipedon*.

2. Near Mt. Victory, Hardin County (80 miles south of Toledo), five adult specimens of *erythrogaster*, one of which (No 1690),[3] collected July 23, 1932, gave birth to eight young September 30, 1932, and one (No. 1662), collected May 29, 1932, had 18 well formed embryos removed from her upon her death October 23, 1932. Two specimens of *sipedon*, one of which (TZS No 1518) collected July 23, 1932, gave birth to 13 young September 14, 1932

The only Ohio record in the literature is by Morse (1904, p. 131), who mentions collecting *Natrix fasciata erythrogaster* Shaw at Put-in-Bay, but the only specimen (No. 41) in the collection of the Ohio State Museum identified as *erythrogaster* and bearing Morse's name as collector is definitely *sipedon* The writer has examined 202 specimens of water snakes from the Ohio Lake Erie islands and the adjacent mainland without finding a single one which approaches *erythrogaster*, although several have a pinkish or light orange mid-ventral surface as do others from various parts of the state and particularly from southern Ohio. A large percentage of the specimens from the islands exhibit peculiar abnormalities of pattern which it is planned to discuss in a longer paper now in preparation.

From the above it will be seen that there is available a total of 42 specimens of *erythrogaster* and 17 of *sipedon* from the Williams County and Hardin County localities. A careful

[3]All of the known specimens of *erythrogaster* from Ohio are in the collection of the Toledo Zoological Society except No. 443 in the Ohio State Museum and two individuals in the private collection of Dr Frank N. Blanchard, of the University of Michigan

study of this material shows that it agrees in practically every detail with Clark's (1903) specimens from near Olivet, Michigan

The most conspicuous difference between adult Ohio specimens of *sipedon* and *erythrogaster* is in color. In the latter the dorsal surface is uniform black or brownish black with the belly uniform bright red or scarlet, except for the antero-lateral portions of the ventral scutes which are black or blackish. In *sipedon* the upper surface is usually patterned with a mid-dorsal and lateral series of dark blotches, these being subquadrate in form and superimposed upon a paler ground color. In many of the darker specimens, however, the blotches may be more or less confluent The belly pattern normally consists of dark semicircles on a lighter ground, but these markings are often reduced or are represented by dotted or clouded areas, while in some individuals the belly may tend towards uniform black, never uniform red as in *erythrogaster* A light midventral area which varies from white to yellow, orange or pink extends from the chin nearly, or quite, to the anal plate in many specimens This condition has not been seen in *erythrogaster*.

Young specimens of both *sipedon* and *erythrogaster* have a well marked pattern of blotches on a paler ground, but the arrangement of these is different in the two forms In *erythrogaster* the lateral blotches alternate with those of the dorsal series farther forward than in *sipedon;* in both forms the tendency is for the most anterior dorsal and lateral blotches to unite, forming dark crossbands, but this tendency is much more marked in *sipedon* than in *erythrogaster* In *erythrogaster*, of the total of 31 to 42 blotches from the head to a point directly above the anal plate, the fusion occurs in from 1 to 9 of the most anterior blotches with an average of 3 7. In the series of 17 *sipedon*, of the 30 to 37 blotches, the anterior 8 to 14, average 10 6, do not alternate. The average for the series of 100 *sipedon* is also 10 6. In several of these latter specimens the blotches are united to form the above mentioned crossbands almost throughout the length of the body, but in one (TZS No 540), from Geauga Lake, Geauga County, they are alternated forward to the head although otherwise the specimen exhibits typical *sipedon* characters.

The belly in juveniles of both forms is similar to, but paler than, that of the adults.

TABLE I.

VARIATIONS IN OHIO SPECIMENS OF *Natrix sipedon erythrogaster* AND *Natrix sipedon sipedon*.*

CHARACTERISTIC	*Natrix sipedon erythrogaster*		*Natrix sipedon sipedon*			
	1 From Hardin and Williams Counties	No.† 40	1 From *erythrogaster* Localities	No.† 17	2 From Various Ohio Localities	No.† 100
Ventrals ♂	149 to 156 average 151.8	18	138 to 143, average 140.9	8	135 to 149, average 140.6	52
Ventrals ♀	149 to 157, average 153.5	22	141 to 145, average 142.1	9	135 to 149, average 141.7	48
Ventrals ♂ and ♀	149 to 157, average 152.7	40	138 to 145, average 141.5	17	135 to 149, average 141.1	100
Subcaudals ♂	71 to 84, average 76.8	17	70 to 76, average 73.1	8	68 to 78, average 73.3	45
Subcaudals ♀	64 to 74, average 67.4	17	60 to 64, average 62.3	9	57 to 70, average 62.0	42
Subcaudals ♂ and ♀	64 to 84, average 72.1	34	60 to 76, average 67.4	17	57 to 78, average 67.9	87
Ventrals + Subcaudals ♂	223 to 236, average 228.6	17	206 to 218, average 214.0	8	206 to 224, average 213.8	45
Ventrals + Subcaudals ♀	216 to 228, average 221.5	17	203 to 208, average 204.4	9	194 to 217, average 208.7	42
Ventrals + Subcaudals ♂ and ♀	216 to 236, average 225.1	34	203 to 218, average 208.9	17	194 to 224, average 208.9	87
Eye/Head, Adult ♂	20.4% to 23.0%, average 21.9%	6	21.2%	1	19 % to 23.2%, average 20.4%	18
Eye/Head, Adult ♀	21.1% to 25.1%, average 22.5%	8	19.3% to 19.4%, average 19.35%	2	18.1% to 21.0%, average 19.5%	14
Eye/Head, Adult ♂ and ♀	20.4% to 25.1%, average 22.2%	14	19.3% to 21.2%, average 20.0%	3	18.1% to 23.2%, average 20.0%	32
Eye/Head, Juvenile ♂ and ♀	23.8% to 27.2%, average 25.1%	8	19.2% to 22.6% average 21.6%	14	19.8% to 22.4%, average 21.3%	30
Blotches from Head to Anus	31 to 42, average 35.7	26	30 to 37, average 34.3	17	26 to 43, average 33.7	80
Blotches not Alternated ♂	1 to 9, average 4.4	12	8 to 13, average 10.1	8	1 to 32, average 11.3	38
Blotches not Alternated ♀	1 to 8, average 3.1	14	8 to 14 average 11.0	9	1 to 27, average 9.8	39
Blotches not Alternated ♂ and ♀	1 to 9, average 3.7	26	8 to 14, average 10.6	17	1 to 32, average 10.6	77

*Imperfections in many specimens prevent complete counts of all characters as.
Only specimens with perfect tails are included in the counts involving the number of subcaudals.
Embryonic specimens are not included in the measurements involving the eye.
Specimens having obscure or very irregular markings are not included in the figures concerning the number of blotches.
All juvenile specimens of *sipedon* included in the computations are under 300 mm in length.
All adult specimens of *sipedon* are 506 mm. or more in length, this being the size of the smallest large *sipedon* from the *erythrogaster* localities.
†The figures in these columns refer to the number of specimens involved in each series of extremes and averages.

In a series of eight newly born young of *erythrogaster* (from specimen No. 1690) the coloration in life of the dorsal and lateral blotches is black on a ground color of orange brown shading from Mars Orange[3] to Sanford's Brown, although this color is paler in the narrow lines separating the adjacent dorsal blotches. Median blotches are three or four scales long and from nine to eleven scales wide. Lateral blotches are two or three scales wide and extend from the edges of the ventrals to the eighth or ninth row of scales. The belly is uniform orange, ranging from Bittersweet Orange to Orange Rufous, except for the anterolateral edges of the ventrals, which are blackish. The labials are the same color as the belly but the sutures between them are darker and are almost black in some cases. There is a patch of white on the chin shields and gulars.

Both forms tend to darken with age. In *sipedon* the blotched pattern usually persists throughout life although occasional large specimens may approach uniform blackness In *erythrogaster* the juvenile pattern is replaced by the uniform colors of the adult. A freshly shed specimen of the latter 855 mm. in length shows a faint indication of the blotches which can be counted when held in the proper light. The number of blotches, 33, the anterior four of which do not alternate, falls well within the range of variation as shown above in the series of juveniles.

Correlated with the differences of color and pattern are differences in scutellation. The ventral scutes, including the divided anal plate, average 11.2 higher for *erythrogaster* than for *sipedon* from the same localities and 11.6 higher than for the 100 specimens of *sipedon* from various parts of the state (see Table). The extremes for each form are from 149 to 157 and from 135 to 149, respectively; only at 149 do they overlap, which number is seen in two *sipedon* and only one *erythrogaster*.

The number of subcaudals averages somewhat higher in *erythrogaster*. In males there are 71 to 84, average 76 8, while in males of *sipedon* the limits are found to be 68 to 78, average 73.3. The females of *erythrogaster* vary from 64 to 74, average 67.4; of *sipedon* from 57 to 70, average 62. Both sexes considered together range from 64 to 84 in *erythrogaster* with an

[3]Capitalized color names are those of Ridgway's "Color Standards and Color Nomenclature" (1912).

average of 72.1 and from 57 to 78 in *sipedon* with an average of 67.9.

The higher number of scales in *erythrogaster* is best shown by adding the number of subcaudals to the number of ventrals in each form and comparing the results. Thus it will be seen that *erythrogaster* averages 16.2 more than *sipedon* as is shown in the table.

The eye is somewhat larger in *erythrogaster*, this being particularly noticeable in the young. If the diameter of the eye be divided by the length of the head, measured from the tip of the rostral to the posterior tip of one of the parietals, a figure suitable for making comparisons is obtained. In eight juvenile *erythrogaster* the eye ranges from 23.8% to 27.2%, average 25.1%, of the length of the head; in 13 juvenile *sipedon* from 19.2% to 22.6%, average 21.6%. Juveniles in the series of 100 specimens show nearly the same range and average. In adults the eye of *erythrogaster* is found to average 2.2% larger than in *sipedon*.

Aside from the differences evident in pattern, color and scutellation, certain facts concerning habits and habitats indicate further dissimilarity. *Sipedon* occupies a variety of situations and appears to thrive wherever there is a sufficient quantity of water to assure it a food supply and a haven of retreat. *Erythrogaster*, on the other hand, in both Ohio localities, inhabits the environs of small woodland ponds which frequently become dry in midsummer, and in these localities it is much more abundant than *sipedon*, only two of the latter have been taken in each place, while on May 7, 1932, over 30 specimens of the former were seen in Williams County. *Erythrogaster* has been found much farther from water than any of the several hundred *sipedon* which the writer has collected in the state, and one of the Hardin County individuals was encountered fully 200 yards from the nearest pool. It is the writer's impression that *erythrogaster* is more vicious than *sipedon* and that it is more wary and consequently more difficult to capture.

Of the large number seen on May 7th in the Williams County locality several pairs were breeding and the entire colony appeared to be alert and active; one male specimen swam close enough to the writer to be easily seized. The behavior of this individual was unusual but possible explanations might be found in the mating activities or in the fact that the writer

reeked with the musk-like secretion of the caudal glands which had been liberally sprayed on his person by previous captives.

The present Ohio records, with Clark's (1903) record from Olivet, Eaton County, Michigan, extend the known range of *erythrogaster* a considerable distance to the north. According to Blanchard (1925a, p. 10) this form occurs from the "Lowlands of Virginia and the Carolinas, west to Louisiana and north in the Mississippi Valley into southern Illinois" Additional locality records are available from southwestern Indiana and adjacent Kentucky (Blanchard, 1925b, pp. 384–385), but specimens are apparently lacking between this area and northwestern Ohio. This absence might be a result of the intensive cultivation which, with the attendant draining of the land, has doubtless destroyed many habitats suitable for *erythrogaster*. Careful search, however, will probably reveal it in additional localities in Ohio, Indiana and Michigan

CONCLUSIONS.

1. The data presented show that *Natrix sipedon erythrogaster* (Forster) is entitled to recognition as maintained by Clark, Blanchard and Taylor

2 A study of Ohio material shows that *erythrogaster* may be readily distinguished by differences in color, pattern, scutellation, size of eye and habitat from *Natrix sipedon sipedon* (Linné), with which it has been confused

3. The range of *Natrix sipedon erythrogaster* should be extended to include northwestern Ohio and, in view of Clark's (1903), record southern Michigan

AUTHOR'S NOTE

Since the above paper was read before the Ohio Academy of Science on April 4, 1933, certain pertinent data have come to hand which it seems advisable to sum up briefly. The Blakeslee locality was revisited April 22, 1933, and twelve specimens of *erythrogaster* were secured, among them the first juvenile to be encountered in the field. This specimen, 388 mm in length, agrees in detail with the juveniles born to a Hardin County female as described in the paper except that while the blotched pattern is still discernible along the sides, the dorsal surface is nearly uniform blackish brown above and the belly is somewhat paler and more yellowish.

An adult pair was discovered in mating position on this date, while another male lay coiled nearby. Two of the twelve specimens have been preserved; the others are being kept alive.

ACKNOWLEDGMENTS.

The writer wishes to express his indebtedness to the following persons for aid in the preparation of this paper and for assistance rendered by collecting specimens of *erythrogaster* in the field: Dr. Frank N. Blanchard, Howard K. Gloyd, Wm. M. Clay and Arthur Greenhall of the University of Michigan, Karl P. Schmidt of the Field Museum of Natural History, Charles F. Walker of the Ohio State Museum, and Anne Huch Conant, Charles Burris (who first called the writer's attention to *erythrogaster* in Ohio), Clarence L. James, M. K. Murphy, Byron Gardner, Jr, David Delzell, Cecil Murphy, James Kitzmiller, Jr., Leo Higgins Lawrence D. Hiett and Robert Mattlin, all of the Toledo Field Naturalists' Association.

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FIG. 1 (Upper.) Juvenile specimen of *Natrix sipedon erythrogaster* 9 months old and 355 mm in length. The pattern, while still apparent, is rapidly becoming obsolete. This snake was born in captivity September 30, 1932 to a female (TZS No. 1690), collected near Mt. Victory, Hardin County, Ohio. Photo by Lawrence D. Hiett.

FIG. 2. (Lower.) Adult male *Natrix sipedon erythrogaster* 1106 mm in length, collected April 22, 1933, near Blakeslee, Williams County, Ohio. Photo by Howard K. Gloyd.

FIG. 3. Habitat of *Natrix sipedon erythrogaster* near Blakeslee, Ohio, April 22, 1933. More than half of the known specimens of this snake from Ohio have been taken in or near this small pond. Photo by William M. Clay.

A MORPHOLOGICAL STUDY OF WORTHINGTON, OHIO.[1]

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Many of the factors affecting the location, development, and future status of any urban center are of a geographic nature. These factors vary with time and place. Leighly states that, "Their combination at a given place and moment of time is probably absolutely unique."[2] Thus, although the results of the following study of Worthington, a suburban village of Columbus, Ohio, are no doubt true in a broad way of suburban towns in general, the primary interest of this paper is the description and explanation of the unique phenomena in the morphology of this particular chorographic unit.

HISTORICAL BACKGROUND.[3]

During the winter of 1801-02, a colonizing association known as the Scioto Company was formed in the states of Massachusetts and Connecticut. The following spring Col. James Kilbourne, one of the members, set out for the Ohio territory in search of suitable land for purchase and settlement. After traveling many miles on foot through the wilderness, he selected 16,000 acres of land on and near the Olentangy River in what is now Sharon township of Franklin County, Ohio.

In "Articles of Association," the members of the company had agreed in writing that two roads should be laid out in this newly purchased tract; one to run north and south, the other east and west. It was further agreed that a village of one hundred and sixty acres, divided into one hundred and sixty lots, should be laid out at the intersection of the roads. The four lots lying on the four central corners were to be reserved as a public square, and one lot each was to be reserved for church and school purposes. The first settlers arrived on the 20th day of October, 1803, and the following May the village of Worthington was laid out as planned.

[1]The writer wishes to acknowledge the assistance of Dr. Guy-Harold Smith, Department of Geography, Ohio State University, under whose direction this investigation was made.

[2]John B. Leighly. "The Towns of Malardalen in Sweden, A Study in Urban Morphology," *University of California Publications in Geography*, Vol. 3, No. 1, 1928, p. 3.

[3]"*History of Franklin and Pickaway Counties, Ohio,*" Cleveland, 1880, pp. 418-433.

THE FACTOR OF SITE.

The first settlers naturally settled on a site considered the best for the proposed community, a site which met the demands of early Worthington in an admirable way The retreat of the glacier left the region a till plain in which the drainage system as a rule cut out valleys and glens having steep bluffs rising from narrow flood plains However, the bluff upon which Worthington was located rose from the east side of the Olentangy with a more gradual slope than usual Two tributary creeks had by headward erosion formed a saddle which isolated a summit part way up this slope Worthington's public square and the intersection of its two main streets were placed exactly at the top of this summit The village was therefore well drained in every direction

Good drinking water, made accessible by natural springs and driven wells, was to be had from the lenses of gravel common in the glacial till The location of the community on a west facing bluff heightened the agreeable and invigorating nature of its climate Nearby level uplands, occupied by intermingling tracts of hardwood forest and open prairie, provided natural resources of value in the establishing and maintaining of the settlement Along with the rich bottom lands of the Olentangy, these uplands furnished suitable lands for agriculture The forests supplied timber and fuel, but were not so dense as to dishearten the people or to hinder greatly the development of agriculture and transportation The former head of Olentangy navigation was at a falls just above the village, and for a number of miles upstream from this point, swift flowing shallows provided tempting mill sites Communication from the village to the immediate locality was easy

The relationships between man and environment are dynamic, however, and thus some of the former advantages of Worthington's site are of little present-day importance The water power sites and the navigability of the Olentangy are no longer of prime significance The forests have disappeared, but the fertile fields remain The drainage factor is also still important, and the principal source of water supply is still from artesian wells near the village The greatest advantage of site at present, however, is that ample room exists for comparatively unrestrained growth of the village. Only the steep west bluff on the opposite side of the Olentangy offers any serious obstruction.

FACTORS OF SITUATION.

The situation of their village probably gave the founders of Worthington little worry, for as yet few settlements existed in Ohio Conditions of communication forced each of these to be largely self-sufficient, and being so, their location one to the other was not nearly so basic a consideration as was the selection of suitable local sites Nevertheless, one angle of situation usually considered in these early times was accessibility to a route connecting the frontier with the mother states east of the Appalachians By way of the Scioto River, Worthington had easy access to the Ohio River, the chief route of interior travel and trade of that time

In 1812 the city of Columbus was founded as the result of the location there of the State Capital This would appear to be the critical point in both the history of Worthington and Columbus Worthington made a strong competitive bid for the capital, but due to a political maneuver lost out at the last moment Though the site of Columbus was more favorable for the growth of a large city, there is reason to believe that had the capital been established at Worthington, the relations of Columbus and Worthington would be much different today At all events, the location of the capital at Columbus gave it the impetus which made it the larger city Proximity to this large and growing city has been the greatest single factor of situation influencing Worthington's morphology

Columbus naturally became the focus of communication routes In 1823, the legislature passed an act incorporating a joint stock company for the construction of a Columbus to Sandusky Pike This road, following the east bluff of the Olentangy, passed through Worthington It connected with the Scioto Trail and the National Road at Columbus, and soon became a principal route of travel to northern Ohio Today it is a part of the important Portsmouth, Columbus, Toledo, State Route 23 The main east-west street of Worthington became a part of the Newark to Marysville Pike Thus Worthington was and is well situated so far as road communication goes In 1868, the Sandusky Branch of the Cleveland, Columbus, and Cincinnati Railroad was built It nearly missed Worthington, for in order to avoid the making of a large number of cuts, fills, and bridges, the right of way followed the level interior of the till plain considerably east of the Olentangy. The railroad in so nearly missing

Worthington probably influenced the plan of the town somewhat, as will be shown.

FUNCTIONAL CHANGES AS DEMONSTRATED BY WORTHINGTON.

For a time after its founding, Worthington probably performed a purely rural function. The first settlers entered a virgin territory where they were not constrained by former inhabitants to settle definite spots Man being normally a gregarious rather than a solitary creature, these pioneers settled in a group The nature of their settlement was reminiscent of the New England villages from which they had emigrated Its compact character prepared it for Indian attacks which never materialized, while enough land could be cleared within a radius of say two miles to form a sufficient physical resource for the support of the people. To meet the simple needs of the people, the products of this resource were slightly processed by such embryonic industries as the grist, shoddy, and saw mills. The village common was the dominating influence, for around it revolved the religion, politics, education, commerce, and home life of the village. It was the common ground for exchange of goods, experiences, and ideas. Thus early Worthington furnished for a time an environment of agriculture, local common interests, and all-around living [4]

Worthington did not for long retain this rural character. Later settlers, forced to take land farther and farther from the rural center, found it more advantageous to live on the land they were working rather than to travel back and forth to the village morning and evening Thus, although Worthington still acted in a rural capacity for some of its inhabitants, its function as a cross roads service center for the surrounding country became more important. The dominating factor was no longer the common, but the larger agricultural area

The population of Worthington had increased from 100 in 1804 to 440 in 1840 [5] Broadly speaking it might be said that a population of 100 to 200 represented the era of rural function, while one around 400 represented the era of cross roads function From 1840 to 1880, with the exception of a minor fluctuation in 1860, the population remained practically stationary. The census of 1860 recorded 349 people. This temporary drop was

[4] Benton Mackaye. "*The New Exploration, A Philosophy of Regional Planning*." New York, 1928, p 59

[5] Population statistics from United States Census Reports.

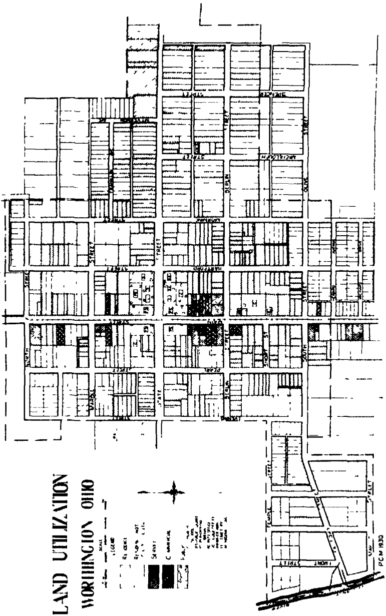
probably due to migration to more western lands. Shortly after 1880, however, the population took a sudden drop and did not again rise above 400 until 1900. In 1890 the population was only 341. It is not at all improbable that the fall in population at this time was caused by the removal of part of the inhabitants to Columbus, for along about 1880 the great industrial consolidations and the consequent growth of banking and insurance facilities caused a wide-spread migration to the cities. Worthington was becoming a drained village so common at that time Thus for the first time Columbus became the dominating influence in the history of Worthington The village still retained its cross roads function, but to a greatly lessened degree, however, for with the growth of transportation facilities, the sphere of Columbus influence was greatly enlarged Many farmers who formerly came to Worthington now went to Columbus to do their marketing and buying

The sudden migration to the larger cities soon proved somewhat of a boomerang, and a counter flow set in With development of transportation facilities, people in search of enough ground and air to afford them better living conditions than cound be found in the city, moved to the suburban areas and commuted to their work in the city proper Worthington was close enough to Columbus to profit by this backwash, and from 1900 to the present time its population has increased. In 1910 it was 547, in 1920, 705; and in 1930, 1,239. During this period Columbus still was the dominating influence, but now in such a way as to change Worthington's predominant function to that of a suburb of the super-urban Columbus.

With the corporate limits of Columbus now within one and one-half miles of those of Worthington, where formerly a space of nine miles separated them, and with both the centers constantly increasing in population and size, it is rather sound theory to forecast their union within a few years. Worthington will have become a submerged village, losing its identity to that of Columbus as a whole It will then be serving a new function, that of a sub-retail area of Columbus.

GENERAL GROUND PLANS.

The original political pattern of Worthington included one hundred and sixty acres as provided for by the "Articles of Association." This rectangular plot was laid out with its main axis along the north-south road. The first subdivision to be


LAND UTILIZATION
WORTHINGTON OHIO
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added, lay to the east of the original plot where a level continuity of relief afforded satisfactory building sites. The expectancy that these sites would soon be utilized doubtless caused their inclusion in the political unit. Later when the railroad passed slightly to the east of the village in 1868, the desire to have an outlet in this direction probably led to the further extension of the political boundary towards the east In temperate zones, if no constraints exist to westward expansion, the growth of an urban unit is often westward since the prevailing winds makes the westerly sections more healthful Two hundred acres just west of Worthington as originally laid out, were reserved for Church and School purposes by the "Articles of Association." This fact has to date no doubt prevented the inclusion of this land within the corporation limits, although the political boundary has been extended to include an area of subdivided land lying to the southwest

The human occupancy pattern of Worthington, or the areas of land actually occupied by buildings, has assumed the shape of a rude cross which is elongated in an easterly direction At the intersection of its arms is the public square The core of the village, a region of low dwelling density, but complete space utilization for business and public purposes, is just to the south The first settlers naturally built their homes around the public square at the intersection of the two main roads As more settlers came, expansion was primarily along the more important north-south road to points where the glens of tributary creeks of the Olentangy formed temporary barriers Growth then took an eastward direction along the main east-west road which gave access to the level upland till plain, joined the original road from Zanesville to Columbus at Newark, and later gave access to the railroad Expansion in a westerly direction was constrained beyond a certain point by School and Church ownership of the land and by natural restrictions furnished by the Olentangy River. As expansion progressed along these main routes, the intermediate areas were gradually being occupied. The human occupancy pattern has now expanded beyond the glens which partially blocked north-south growth and in the near future it is probable that the greatest growth will be in these directions.

Lands lying in the path of probable directions of human occupancy are usually subdivided long before their use as building sites is demanded. Human occupancy of lands may

take place spontaneously in some unforeseen direction, but no sooner does this happen than lands in that direction are subdivided in expectancy of further expansion. Then again, isolated subdivisions may be established outside of the general forecasted path of expansion with the hope that they can be exploited in such a way as to draw the occupancy pattern in that direction Worthington's pattern of expectancy of future human occupancy, or the pattern of the various idle or partially idle lands subdivided and held for speculation, though irregular, extends farther to the north and south than in other directions.

MORPHOLOGY OF COMPONENT UNITS· THE LOT.

The lot is the truest and basic component unit of the village, for upon the lots are placed the cultural units which combine to form the village. Worthington was first laid out in rectangular parcels, roughly 134 x 252 feet, or about an acre in area (See map). During the first few years when the people lived in the village but gained a living from the outlying fields, the lot on which they lived had to be large enough for the home, a vegetable garden, a barn and other buildings Land was cheap and plentiful. Thus, the first division of the village land into acre units would seem to be a natural arrangement.

As time went on and Worthington no longer performed a purely rural function, it was not necessary for the lots to be as large as formerly Land was less plentiful and more valuable as population increased Since street assessments were based on front footage, it was cheaper to have narrow lots Thus in the first sub-division just east of the original village, plots 66 x 332 feet were laid out Another probable reason for the narrow frontage of these lots was the desire of the subdivider to have as many lots as possible facing the main streets. As peripheral expansion takes place, there is also a simultaneous interior expansion. Thus many of the acre lots in the original village were cut up to meet the new conditions

Still later, as land became even more valuable, complete space utilization was increasingly important. The era of individual self-sufficiency had passed No longer were vegetable gardens the rule Village land was becoming too valuable to be used as garden space. Consequently the size of the lot in the most recent sub-divisions averages about 50 x 150 feet. This is large enough for the home, the garden and the small yard.

A glance at the map and the restraining influence of the past

is apparent. Natural property divisions of the past become weaknesses of today.[6] The original acre plots have been broken into lots of various sizes, many of which approach present-day standards But these acre plots cannot be completely broken up into the smaller lots of today unless additional streets are laid out This has been done in the reparcelling of the north west square (See map) The establishment of more streets would also help to bring the long lots of east Worthington into tune with present day needs

THE STREETS

Early Worthington was laid out according to a definite preconceived plan. The streets followed a rectangular pattern. In other words they intersected at right angles and in the case of Worthington ran in true north-south and east-west directions A street pattern of this nature is easily laid out It gives straight streets, facilitates location, and makes possible the division of the land into rectangular or square units One prerequisite, however, is that the physical landscape be fairly uniform.

The two main streets intersecting at the center of the original plot are 99 feet wide The first streets away from this intersection in every direction are 66 feet wide The four intersections of the second streets away in every direction form the corners of the original village. These streets are 49½ feet wide. No alleys were provided for in the original plan, and except for private use few have been added Today this section which represents the original village retains the streets as first laid out, except for the addition of two new streets as the result of changes in the size of lots Individual land parcels may be split or a building moved, but the alteration of a street to any great degree is rather hard since it has become fixed in regard to all buildings and land units along its length

In Worthington, planned peripheral expansion has usually anticipated that of a spontaneous nature. The first addition, to the east of the original village, was on fairly level land which permitted the continuation of the general rectangular plan without much difficulty, although it was modified somewhat through the inclusion of more streets as a result of the different shape and size of the lots. Recent subdivisions north and

[6]Robert S. Platt. "Geography of a Sugar District, Mariel, Cuba," *Geogr Rev*, Vol. XIX, 1929, p 604

south of the village have a planned pattern, but one which illustrates more recent subdivision practices. The pattern is irregular in many places in that streets are laid out to conform with natural features. At other places the streets are curved for purely aesthetic reasons Thus, as these new subdivisions become a part of the village, the rectangular symmetry of the present street pattern will be destroyed.

THE HOME.

Rude log cabins constructed from the most plentiful and easily used building material at hand satisfied the new settler's immediate need for shelter, but no sooner had the routine life of the village been established than these log huts began to be replaced by the type of home the people had been accustomed to in Massachusetts and Connecticut. The log cabins have thus disappeared, but many of the colonial type homes of the next period are still standing. The most common is the characteristic two-story, rectangular, brick building with a chimney at each end. The long axis of these houses paralleled the street. Often several were built end to end, a customary trait inherited from the east where the earlier homes had been constructed in this manner around the public square as a center and thus presented a solid front to Indian attacks. (Figure 1.)

Following the colonial period came an intermediate period during which the size of homes was increased. (Figure 2.) Homes of several types are representative of this period when style dictated that each house have one or more rooms standing idle a great part of the time, to be used only on special occasions. Building materials were plentiful and comparatively cheap. The houses were either of brick or timber, and were as a rule set back fairly well from the street. Those built during the latter part of the period were more commonly of timber since the extensive exploitation of our forest resources at that time made wood the cheapest building material.

The modern homes are the familiar types of small, fully lived in, well constructed units. These are set near the street, leaving only a small front yard with a fair-sized yard to the rear. Situated sometimes in connection with or near the house, other times at the rear of the lot, and usually attained by means of a front drive from the street, is the garage. This is the only outbuilding customary with the modern home unit. As yet few doubles and only one apartment house exist. The

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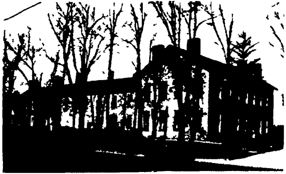

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Fig 1 (Upper) Colonial type buildings. Note end to end construction and characteristic chimneys. This group once served as a tavern, and is now utilized as residences. The building to the right fronts on the public square.

Fig 2 (Lower left) One type of residence constructed during the intermediate period. The mansard roof, architecturally of French origin, was popular about this time because it afforded an increased top story area.

Fig 3 (Lower right) Worthington's only apartment house was formerly a girls dormitory for a now defunct normal school.

4 5

6 7

FIG 4 (Upper left) Part of the retail district On the right is the oldest standing building in Worthington At one time part of an inn, later used as a school building and still later as a residence, it today serves as a funeral home The next building to the left was recently destroyed by fire, and has been replaced by a modern storeroom the colonial design of which harmonizes with the buildings on either side

FIG 5 (Upper right) A building constructed in 1856 for public school purposes, and used since 1871 as Corporation and Township offices

FIG 6 (Lower left) The oldest church in Worthington, built in 1828 A corner of the larger modern church, recently built on the same lot, is seen to the right In the background to the left is a school building, in the foreground part of the public square

FIG 7 (Lower right) Built in 1820, the Masonic Hall is a good colonial type building It is the oldest Masonic building west of the Alleghenies and is said to be the oldest building in the United States that has always been used exclusively for Masonic purposes

apartment building represents the present utilization of a building formerly used as a dormitory, first for a Methodist Female Seminary, and later for a Normal School replacing it. (Figure 3.)

THE PUBLIC BUILDINGS AND GROUNDS.

Commons were characteristic features of early New England villages, and as already indicated the first settlers carried the idea along to embody it in the structure of Worthington In spite of the passing of its combined speaking and band stand, the public square still serves as the place of occasional public gatherings. Besides providing for a public square, the village founders provided land for school and church purposes. Coming from a section of the country benefited by good schools, they naturally showed a great interest in education Almost the first building to be erected was used as a school house. In 1808 the Ohio Legislature passed an act incorporating a school under the name of Worthington Academy, later known as Worthington College, and still later as the Reform Medical School. This last removed to Cincinnati in 1843 The old college buildings were then used to house grade school until they were torn down and replaced by the present public school buildings in 1875.

A preparatory school for Kenyon College at one time occupied the old Kilbourne Hotel, which was situated on the southwest corner of the public square. This school was abandoned in 1863 and the building subsequently served for some time as a residence. The portion still standing today is utilized as a funeral parlor. (Figure 4) A Methodist Female Seminary, later the Ohio Central Normal School, flourished for a time in Worthington and left its mark on the morphology of the village in the present apartment house

The first public school building erected after the passage of the State School Law was built about 1856 in the rear of the Episcopal church lot Its upper story was leased for a term of five years to the Independent Order of Odd Fellows. (Figure 5.) In 1871, upon the removal of the school to the old College buildings, this building was sold to Worthington Corporation and Sharon township and has since been utilized for village offices. At present, in addition to the grade school building on the village school lot, a recently built modern centralized high school occupies the school lands just west of the village.

The oldest standing church building was built in 1828 on the church lot southeast of the public square. Recently replaced by a new building, it is now little used. (Figure 6.) Besides this new St John's Episcopal Church, the Methodist and Presbyterian denominations both have large modern church homes Burials in a cemetery established at an early date on the rear of the church lot have long since been discontinued, but many of the old graves still remain.

THE INDUSTRIAL UNIT.

Today not one industrial unit exists in Worthington Small units such as the tannery, saw mill, grist mill, cooper shop, cabinet shop, and woolen mill, which existed during the era of community self-sufficiency prior to the industrial consolidations of the 1880's, have disappeared Many of these small industries were housed on the same lot as the home of their owner and operator They were thus confined to no specific locality in the village One rather interesting industrial experiment, a forerunner of the modern factory system, took place in early Worthington. In 1811, Col. Kilbourne and others incorporated a stock company under the name of the Worthington Manufacturing Company A tannery, a shoe shop, a cloth mill, a hat shop, a blacksmith shop and other industries were combined under one roof and one management. This company flourished for a time, having outlets through stores in Worthington, Columbus, and Franklinton, but it finally failed. The factory was located southeast of early Worthington on land now within the corporation limits A building used as employees' living quarters is still standing

THE RETAIL BUSINESS UNIT

Today the retail business district of Worthington is concentrated on High Street just south of the public square. (See map.) Formerly several stores lay north of the square, but most of these have disappeared. Several causes might be advanced for this concentration south of the square. The location of Columbus probably played some part in the drawing of the units in this direction, but this is a rather intangible factor whose importance is hard to determine. Probably a more important factor was that in addition to the buildings originally constructed for store purposes, there existed here several old colonial type homes which, after their days of

residential usefulness, were easily remodeled into inexpensive store rooms. (Figure 4.) Only one or two modern store buildings exist. Then too, the population of Worthington is densest in the southern part of the town and the stores are thus nearer the people. It is interesting to note that only stores providing day by day necessities are found in Worthington. When the inhabitants need something other than groceries, drugs, notions, or hardware goods, they go to nearby Columbus where the larger specialty stores furnish better selections and values. Most of the groceries are sold through chain stores, and it seems to be characteristic of these to locate in close proximity to each other One type of retail establishment is precluded by its nature from joining in the central concentration. This is the antique shop.

THE SERVICE STATION

Garages, filling stations, banks, restaurants, barber shops, etc., may be considered as service units. Here in many cases the influence of Worthington's location to Columbus is distinctly evident It is clear that the people of Worthington alone do not support the five restaurants These are largely dependent on the patronage of persons driving out from Columbus and upon tourists The same is true of the garages and filling stations It is interesting to note that the greatest number of filling stations are on the west side of High Street. This might indicate that they are located thus to be best situated to get the trade of the Columbus motorist entering the village with an empty tank after a long drive in the country, or of the commuter who fills his tank before departing for the city. The service units, other than the filling stations, are concentrated for the most part in the central business district along with the retail stores It first appears surprising that Worthington has no moving picture house, but with access to the superior play houses of Columbus, the people have little use for a minor neighborhood theatre.

In closing, it might be well to state that although geographic factors explain to a certain extent the morphology of a chorographic unit, they will not entirely do so. However, the geographic approach seems to be justified in the study of the structure and function of urban units.

THE ALIMENTARY TRACT OF PENTHE PIMELIA, FABR. (COLEOPTERA· DACNIDAE).[1]

ROSS W BRUBAKER
Ohio State University, Columbus, Ohio

The insect studied, *Penthe pimelia*, Fabr ,[2] is a medium sized (12–14 mm.), broadly oval and depressed beetle of the family Dacnidae It is gregarious in winter, and hibernates beneath the bark of old logs and old stumps in beech woods The specimens used in this study were taken in a beech woods near Columbus The first collection of beetles was preserved during October, 1931, in the following manner: The insects were killed by placing them in water and heating to a temperature of 70° C (158° F), then placed in fixing solutions. Half of them were fixed in Kahle's solution; the remainder in Bouin's solution The mid-intestine was not preserved well enough to permit the cutting away of muscles, trachea, and fat body, without tearing it The Malpighian tubules were also very brittle Microscopic sections were made of various parts of the tracts of many different preserved specimens, but most of them were of no value because of the poorly preserved condition of the tissues. It was necessary to obtain live beetles in order to trace the Malpighian tubules in the gross anatomy studies, and to get better material for making microscopic sections.

Sections made from the alimentary tracts taken from live beetles proved to be satisfactory. The digestive juices of this insect act very quickly upon the epithelial lining of the stomach after it is killed, so the beetle was opened under normal saline solution, and when the tract was entirely uncovered, this solution was removed and the fixing agent (Kahle's Fixative, in this case) was put on. Thus the preserving solution reaches the tract and both kills and fixes the tissues before digestion of the stomach lining occurs.

With the exception of the first dozen or so slides made, all sections of the tract were cut at five microns. The usual method of double staining with Haemalum and Fast Green, FCF

[1]Melandryidae of some authors.

[2]The author wishes to express his appreciation for the helpful suggestions and criticisms of Dr C H. Kennedy, and for the aid given by Dr D. M DeLong in identifying the insect studied

as described in the laboratory outline for the internal morphology course, was followed for practically all of the slides made. A few were stained with Delafield's Haematoxylin and Eosin. However, the tissues did not stain as well with the latter two, so their use was discontinued

The drawings were made with the aid of a microprojector.

Gross Anatomy of the Digestive Tract

GENERAL ANATOMY

The alimentary canal of *Penthe pimelia* Fabr., is a simple tube extending from the mouth to the anus, with only one loop in its entire length. It is about one and one-half times as long as the insect's body The three principal divisions—the fore-intestine, the mid-intestine, and the hind-intestine—are easily distinguished in this beetle (Plate I, Fig 1)

The fore-intestine consists of the mouth, the pharynx, the oesophagus, and terminates at the oesophageal valve

The mid-intestine is straight and of the same structure throughout its length. It begins at the oesophageal valve, and ends at the pyloric valve

The hind-intestine begins at the pyloric valve The Malpighian tubules, six in number, arise at this point They appear singly and at regular intervals around the circumference of the valve The ileum is considerably smaller than the stomach, being only about one-fourth the diameter It goes back from the stomach, turns to the left, under the colon, goes forward into the first abdominal segment, then turns to the right again and goes back to the colon The colon is somewhat larger than the ileum and a little more than half as long The distal ends of the Malpighian tubules are attached to the colon by a sheath of connective tissue The tubules are regularly spaced around the circumference of the colon, each one, however, following a much convoluted path to the caudal end of the colon The rectum is slightly less than half as long as the colon, and connects the rest of the tract with the anal opening It is a straight tube, smaller in diameter than the colon, but larger than the ileum.

The size of any part of the canal varies from these proportions when food is present in it.

GROSS STRUCTURE OF THE FORE-INTESTINE.

The fore-intestine is a short tube about one-fifth the length of the body, extending from the mouth back through the head to approximately the middle of the prothorax, where it joins the mid-intestine It is composed of the pharynx, the oesophagus, the (crop), and terminates at the oesophageal valve.

The ***pharynx*** is the slightly wider part of the tube just back of the buccal opening The ***oesophagus*** is the part of the tube connecting the pharynx to what may be the crop or may be merely a part of the oesophagus which is larger than the rest. This larger portion connects

with the mid-intestine at the *oesophageal valve*, which appears externally as a heavy ring of muscle.

GROSS STRUCTURE OF THE MID-INTESTINE.

The anterior end of the mid-intestine is marked by the muscular oesophageal valve The mid-intestine varies in size, depending upon the amount of feeding the insect had done at the time it was killed. When full of food material, it is nearly cylindrical, perhaps a trifle larger at the posterior end than farther forward, and occupies about one-half the length of the body. The stomach of a beetle which has not been feeding prior to the time of examination is somewhat contracted, and may be only three-fifths as long as when full. The surface of the mid-intestine is covered with many small projections or crypts. These are of approximately the same size the entire length of the stomach. The posterior end of the mid-intestine is marked by the attachment of the Malpighian tubules and by the pyloric valve.

GROSS STRUCTURE OF THE HIND-INTESTINE.

The hind-intestine is approximately two-thirds as long as the body, and is distinctly differentiated into its various parts, that is: the pyloric valve, the Malpighian tubules, the ileum, the colon, and the rectum

The *pyloric valve* is evident externally as a heavier walled portion of the canal at the posterior end of the stomach

The *Malpighian tubules* are six in number and are attached to the canal at the pyloric valve They are evenly distributed around the circumference of the tract They are approximately twice as long as the beetle itself, and are much convoluted. The tubules begin at the pyloric valve, wind around in the body cavity in the region of the ileum, and one loop of each goes forward along the mid-intestine, then back to the colon, where it becomes encased in a sheath of connective tissue surrounding this part of the canal. The tubule becomes more or less flattened after it attaches to the colon, and pursues a zig-zag path caudad under this sheath to the point where the rectum begins, and there ends All the Malpighian tubules are fastened to the colon by this layer of connective tissue or "peritoneum," and are regularly spaced around it The tubules are colorless and very hard to distinguish for a short distance from the point of origin at the pyloric valve. They gradually become more yellow in color as the distance from the attachment increases This coloration is pronounced for the last third of the length of the tubules, but disappears when they enter the sheath of tissue surrounding the colon, and for the remainder of their length they are colorless.

The *ileum* is a slender tube leading from the pyloric valve to the colon As stated in the general discussion of the gross anatomy, the only loop in the main tract occurs in this part.

The *colon* is considerably larger in diameter than the ileum, nearly twice as large, and it is sheathed in a case of connective tissue which holds the Malpighian tubules tightly to it. It appears to be less muscular than the ileum.

The *rectum* is the short straight tube leading from the colon to the anus.

Histological Structure of the Digestive Tract.

HISTOLOGICAL STRUCTURE OF THE FORE-INTESTINE.

The fore-intestine has the same histological makeup throughout its various parts. The tissues present from within outwards are found in the following order Plate I, Fig. 2:

(1) Intima (or chitinous cuticula).
(2) Epithelial layer of cells (Hypodermis).
(3) Basement membrane.
(4) Longitudinal muscle
(5) Circular muscle.

The innermost lining of the fore-intestine is the *chitinous cuticula* which is continuous with that of the outer body wall, and is secreted by the fore-gut epithelium. The intima is in wave-like folds, and its inner surface is more or less dentate up to the oesophageal valve. At the opening through the valve proper, the *intima* is smooth, and it remains so to where it meets the gastric epithelium.

The *hypodermis* is a layer of irregularly-shaped cells just beneath the intima, and parallels the convolutions of this layer The *basement membrane* is not clearly shown

The epithelium is surrounded by a well developed *layer of longitudinal muscles* These follow the waves of convolutions of the intima to some extent and are more abundant inside of pronounced folds.

The *circular muscle layer* is also well developed It is around the outside of the longitudinal muscles, and forms a sheath for the rest of the tissues

Although the oesophagus increases in size as it approaches the oesophageal valve, the relative proportion of the different tissue layers remains the same It is doubtful that this larger portion has any function other than conduction of food, as it is not large enough to be called a crop, nor heavily enough chitinized to be a gizzard

The *oesophageal valve* is a fold of the fore-intestine which extends into the mid-intestine, then turns back on the outside of itself to meet the mid-intestine (Plate I, Fig. 3). This valve has four lobes in cross-section The epithelial cells of the part which extends into the mid-intestine and folds back on itself becomes longer and narrower, finally appearing as a columnar epithelium before the fore-intestine meets the gastric epithelium. The valve is surrounded by a heavy band of circular muscles.

At this point the layers of muscle tissue change their relative position; the circular muscles, which were on the outside in the fore-intestine, are inside the longitudinal muscle layer in the mid-intestine.

HISTOLOGICAL STRUCTURE OF THE MID-INTESTINE

A histological study of the mid-intestine shows it to be similar in structure throughout its entire length. There are five layers of tissue (Plate I, Fig. 4). Starting from the inside, they are:

(1) Peritrophic membrane
(2) Epithelium of endodermal tissue.

(3) Basement membrane
(4) Circular muscles.
(5) Longitudinal muscles

The peritrophic membrane encloses the food material and protects the delicate epithelial cells from the rough particles.

The cells of the epithelial layer vary in structure or shape according to whether they are in the secretory or resting stage Soon after the insect takes in food, the cells become distended and some of them break off to supply digestive fluids (holocrine secretion) (Plate I, Fig. 4). These cells are replaced by new cells formed by certain regenerative tissues contained in crypts (Plate I, Fig 5) In the outer end of these crypts are the masses of regenerative tissue called nidi. Externally the crypts appear as papillae which cover the surface of the mid-intestine They all have the same structure.

The circular muscles appear just outside the basement membrane of the gastric epithelium

The longitudinal muscles, usually only a thin layer, occur outside the layer of circular muscles.

HISTOLOGICAL STRUCTURE OF THE HIND-INTESTINE

The pyloric valve is formed by the extension of a fold of the hind-intestine into the lumen of the mid-intestine (Plate II, Fig 7). This fold is composed of epithelial cells of the hind-intestine, but instead of being more or less cuboid in shape, they become elongated into narrow, closely packed columnar cells These are lined on the inside with a layer of chitin armed with spines These spines persist into the ileum for approximately one-seventh of its length.

The function of these spines is unknown to the writer

The fact that the walls of the tract are noticeably heavier at the pyloric valve leads one to believe that there is probably a heavy ring of muscles there However, in this insect it is not so. The thickness is due to the columnar structure of the epithelium of the hind-intestine, where it extends as a fold into the lumen of the mid-intestine (Plate II, Fig. 6) In fact, there are very few muscles of any kind right at the pyloric valve The well developed muscle layers of the ileum appear just posterior to the valve.

The Malpighian tubules arise as invaginations of the hind-intestine, posterior to the pyloric valve. The hypodermal cells at the beginning of the tube are columnar, as are those forming the valve, but they gradually assume a more cuboid shape further out from their origin. The chitinous lining can be traced only for a short distance along the invagination forming the tubule A few spines are also found along this invagination. A cross-section of a Malpighian tubule reveals that the epithelial cells in it are irregular in shape and have large nuclei (Plate II, Fig. 8).

The ileum has all the principal layers of tissue usually found in the hind-intestine The tissues present, from within out, are:

(1) Intima.
(2) Epithelial layer.
(3) Basement membrane.

(4) Inner circular muscle layer.
(5) Longitudinal muscle layer.
(6) An outer circular muscle layer.

As mentioned above, the intima is provided with spines from the pyloric valve for a short distance into the ileum, approximately one-seventh of the total length of the ileum (Plate II, Fig 9).

About half way from the pyloric valve to the colon, the waves or folds of the intima begin to appear as six more or less distinct projections. This becomes more and more pronounced, and by the time the colon is reached there are six well marked divisions (Plate II, Fig 10).

The epithelial cells are more or less irregular in shape and vary in size to some extent, increasing slightly in size as they leave the pyloric valve region By the time the colon is reached, these cells are comparatively large and more distinct

The basement membrane is visible only in a few of the sections examined.

The inner circular muscle layer is well developed the entire length of the ileum.

The longitudinal muscle layer is well developed for a short distance posterior to the pyloric valve, then gradually dwindles to a few scattering muscles where the spines on the intima disappear Approaching the colon, the longitudinal muscles develop into six well marked bundles (Plate II, Fig. 10).

The outer circular muscles are well developed also for the same short distance as the spines on the intima, but they diminish in number and finally disappear at the same level as the spines.

The colon is thinner walled than the ileum, and has the following layers of tissue from within out:

(1) Intima
(2) Epithelial layer.
(3) Basement membrane.
(4) Circular muscles (inner).
(5) Longitudinal muscles.
(6) A sheath of connective tissue or "peritoneum" which encases the distal ends of the Malpighian tubules between it and the colon proper.

The intima in the colon is smooth. Its wave-like folds nearly fill the lumen at the anterior end of the colon, but recede somewhat toward the caudal extremity.

The epithelial cells are comparatively large and distinct. This layer of cells follows the intima closely

The basement membrane is apparent in some sections.

The circular muscle layer is distinct, and forms the thin wall of the colon. It is composed of three layers of muscle cells.

The longitudinal muscles are present in six well developed bundles, each situated at the bottom of the division between the six folds of epithelium in intima.

The "peritoneum" or connective tissue is a delicate layer of thin nucleated cells surrounding the Malpighian tubules and the colon (Plate II, Fig. 11).

In some sections there appeared to be tiny canal-like openings leading from the caudal ends of the Malpighian tubules to the heavy chitin lining the tract at the junction of the colon and rectum. B. J. Landis was the first to call attention to this fact after making studies of the digestive tracts of several species of beetles having the tubules attached to the colon as they are in *P. pimelia*.

The rectum has much thicker walls than the colon (Plate II, Fig. 12). The layers of tissue present are:

(1) Intima.
(2) Epithelium.
(3) Basement membrane (occasionally apparent).
(4) Circular muscle.
(5) A very few strands of longitudinal muscle.

The intima is smooth and is in six folds or pads. If the tract happens to be full of food material, the folds are flattened out into six pads. These begin to extend farther out into the lumen as the caudal extremity is approached, and practically fill all the available space by the time the anus is reached. It is the opinion of the writer that these six pads, while similar to the rectal glands described by others, do not function as glands to any great extent, since their shape (including the structure of the cells) seems to vary directly with the presence or absence of food material in the tract. If they were distended when the tract is full of material, it would seem more likely that they might function as glands. However, they are largest when the tract is empty, and are reduced to a very flat layer when the rectum is full.

The cells of the hypodermal epithelium are slightly smaller and narrower than in the colon, and the cell walls are hard to distinguish.

The basement membrane can be demonstrated occasionally in this part of the tract.

The circular muscle layer is very well developed here. It is composed of six or seven layers of muscle fibers.

The longitudinal muscle layer is present as a very few scattered strands.

SUMMARY.

The alimentary tract of *Penthe pimelia*, Fabricius, is divided into three primary regions, namely. the fore-intestine, the mid-intestine, and the hind-intestine. These regions are more or less differentiated in themselves, showing the following parts:

Fore-intestine—The pharynx, oesophagus, and oesophageal valve.

Mid-intestine—Entirely stomach

Hind-intestine—The pyloric valve, the Malpighian tubules, the ileum, the colon, the rectum.

The layers of tissue present in the different primary regions, from within out, are:

Fore-intestine—Intima, epithelium, longitudinal muscle, and circular muscle

Mid-intestine—Gastric epithelium, circular muscle, and longitudinal muscle.

Hind-intestine—Intima, epithelium, basement membrane, inner circular muscle, longitudinal muscle, outer circular muscle, and "peritoneum."

The Malpighian tubules are six in number, and arise posterior to the pyloric valve at equal distances around the circumference of the tract. They are approximately twice as long as the body of the insect. One loop of each tubule goes forward along the mid-intestine for some distance (different tubules extend different distances) then go back to the colon, where they are attached to it by a thin membrane of connective tissue called the "peritoneum." Each tubule attaches separately and follows a zig-zag path caudad on the colon to the junction of this and the rectum, where it ends

Histological examination of the ileum shows an interesting correlation between the presence of spines on the intima of this division for approximately the first one-seventh of its length, and the presence of well developed layers of longitudinal muscle and outer circular muscle, which also gradually disappear as the spines do Sections posterior to this point show no spines, only a very few scattered longitudinal muscles, and no outer circular muscle layer

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EXPLANATION OF PLATES.

PLATE I

Fig. 1. Dorsal view of alimentary canal.
Fig. 2. Cross section of oesophagus.
Fig. 3. Longitudinal section of oesophageal valve.
Fig. 4. Cross-section of mid-intestine.
Fig. 5. Portion of cross-section through mid-intestine enlarged to show details.

PLATE II.

Fig. 6. Cross-section of pyloric valve showing Malpighian tubule attachment.
Fig. 7. Longitudinal section of pyloric valve showing spines and Malpighian tubule attachment.
Fig. 8. Cross-section of a Malpighian tubule.
Fig. 9. Cross-section of ileum just posterior to the pyloric valve showing outer circular muscle, longitudinal muscle, and spines.
Fig. 10. Cross-section of ileum near colon showing the development of six folds of epithelium and six bundles of longitudinal muscle.
Fig. 11. Cross-section of colon showing connective tissue surrounding the Malpighian tubules and the colon.
Fig. 12. Cross-section of rectum (when empty).

KEY TO ABBREVIATIONS

B. MEM.	Basement membrane
COL.	Colon
C. M.	Circular muscle
C. M. I.	Inner circular muscle.
C. M. O.	Outer circular muscle
CR.	Crypt.
C. TIS.	Connective tissue or "peritoneum"
E. EPI.	Endodermal epithelium
EPI.	Epithelium
F. G.	Fore-gut.
H. EPI.	Hypodermal epithelium.
H. I.	Hind-intestine.
H. SEC.	Holocrine secretion.
IL.	Ileum.
INT.	Intima
L. M.	Longitudinal muscle.
LU. MG.	Lumen of mid-gut.
M. I.	Mid-intestine
M. T.	Malpighian tubule.
M. T. ATT.	Malpighian tubule attachment.
N.	Nucleus.
NID.	Nidus.
OES.	Oesophagus.
OES. V.	Oesophageal valve.
PH.	Pharynx
P. MEM.	Peritropic membrane.
P. V.	Pyloric valve.
REC.	Rectum.
SP.	Spines.

FIG. 1

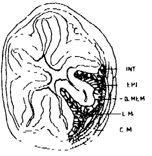


FIG. 2

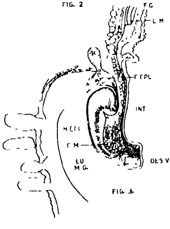
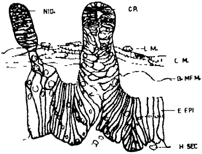


FIG. 3



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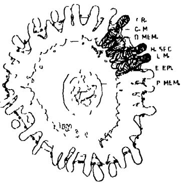

FIG 4.

FIG. 6.

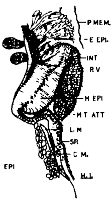

FIG 7

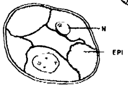

FIG 8.

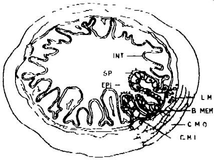

FIG 9

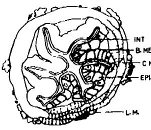

FIG. 10.

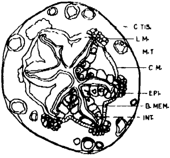

FIG. 11.

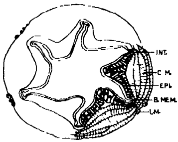

FIG. 12

STUDIES IN THE BIOLOGY OF THE LEECH. II.

Responses of the Leech to Electrical Stimulation.

JOHN A MILLER,
Ohio State University.

INTRODUCTION.

Direct current of low voltage has proven to be an excellent stimulus of motor neurons when the animal can be completely immersed in water. By this means it is possible to effect a direct motor neuron stimulus or motor neuron depression in those neurons which lie parallel to the current The direct current acts as a constant force which results in the production of a prolonged response. (Loeb, Lillie, Shensa and Barrows.) It provides a uniform stimulus, the intensity of which may be changed at the will of the investigator to best serve his needs.

The following group of experiments will illustrate the effectiveness of this type of electrical stimulation.

ANTERIOR POSTERIOR STIMULATION.

The leech[1] to be used in this experiment was placed in a glass tray the bottom of which was kept moist. Movable copper electrodes were placed in the tray in contact with the moist surface of the tray A direct current of 18 volts was used. A reversing switch was connected in the circuit.

The leech was so arranged in the tray that the positive electrode was behind the posterior end of the animal and the negative electrode was in front of the anterior end. When the current was turned on the leech extended to a length surpassing that of normal extension. It maintained this prolonged extension and crawled toward the negative electrode.

When the poles were reversed, that is when the positive electrode was in front of the anterior end and the negative electrode behind the posterior end the leech contracted, and irregular movements of the anterior and posterior ends were pronounced. The anterior end often raised itself from the surface of the container. Following random movements, of the

[1]The leeches used in these experiments were all *Haemopis marmoratis* (Say).

above described nature, the anterior end turned and crawled toward the negative electrode.

Direct current, 18 volts.	
The normal length of the leech extended . .	14 cm.
The normal length of the leech contracted . . .	5 cm.
The average length of the leech	7 cm.
With the negative pole at the anterior end the leech extends to a length of	16 cm.
With the negative pole at the posterior end the length of the leech is . .	7 cm

A similar experiment to the one above was conducted on the earthworm. The results in both cases were identical. Both worms elongated when the negative electrode was placed in front of the anterior end and both shortened when the negative electrode was placed behind the posterior end

An explanation of this phenomenon will be given in a later issue of this Journal.

DORSAL VENTRAL STIMULATION.

A zinc plate was placed in the bottom of a shallow glass container. This container was filled with tap water Near the surface of the water was fastened a galvanized iron screen. This screen was placed an inch to an inch and one-half above the zinc plate A reversing switch was connected in the circuit. Three dry cells supplied the current.

A leech was placed in the container and came to rest on the zinc plate. With the positive charge on the zinc plate and the negative charge on the wire screen the following reaction occurred.

The leech remained with its mid-ventral surface in contact with the zinc plate. The anterior and posterior ends of the leech were raised above the surface of the plate extending toward the wire screen. The middle region of the leech was contracted. The anterior and posterior ends were extended.

When the poles were reversed, i. e., the negative current connected to the zinc plate and the positive connected to the wire screen, the following reaction occurred:

The leech turned over bringing its dorsal surface in contact with the zinc plate. The leech may roll to right or left, even turning completely over, but eventually it comes to rest with the ventral surface toward the wire screen (positive electrode).

The anterior and posterior ends remain in contact with the zinc plate (negative).

When an earthworm was placed under circumstances similar to that of the leech in the preceding experiment, a somewhat different response was noted. In the first place there did not seem to be a definite orientation to the current. The earthworm rolled over and over, contracting violently at times. This difference in behavior may be explained on the basis of the difference in the regions of concentration of the subepidermal plexus in the two animals. Recent reports from the behavior laboratory (unpublished) give for the earthworm lateral concentrations of the subepidermal plexus. When this mechanism in the earthworm is compared with that in the leech there is some basis for explaining the differences in behavior. As stated in a previous paper there are four concentrations of the subepidermal plexus in the leech, two dorso-lateral and two ventral-lateral. (Miller, 1933)

The response to dorso-ventral electrical stimulation of the leech was a direct orientation of the animal. The negative current above the dorsal surface directly stimulated the dorsal longitudinal muscle fibers through the subepidermal plexus. The ventral series of longitudinal muscles were inhibited. Through direct motor stimulation in the anterior and posterior ends the circular muscles at the extremities were contracted This resulted in the leech assuming a U-shaped position.

With the ventral surface of the leech in contact with the zinc plate to which had been attached the negative electrode the longitudinal series of ventral muscles contracted. This contraction resulted in the animal assuming the temporary position like that of an inverted "U." As the leech rolled over, bringing the dorsal surface in contact with the zinc plate, the dorsal series of longitudinal muscles contracted raising the center of the leech toward the wire screen. Throughout this experiment the dorsal surface of the leech has been oriented toward the negative. The anterior and posterior ends had been extended toward the negative. This orientation is the result of direct neuro-motor stimulation on the muscles of the body wall through the subepidermal plexus.

Lateral Stimulation

The bottom of a shallow glass tray was covered with tap-water. In this tray was placed a leech. The positive electrode

was placed to the right of the mid-body region. The negative electrode was placed in a similar position on the opposite side of the animal. These electrodes were placed several inches from the edge of the leech and in contact with the water in the container.

Upon the application of the current the leech twisted and rolled. Very shortly after the initial shock the anterior end turned toward the negative pole. The posterior end raised from the surface twisted and turned toward the negative pole. When the poles were reversed the same reaction occurred on the opposite side.

A similar phenomenon to that described above has been known for some time to take place in the earthworm. Of the explanations that have been advanced to account for this behavior, that of Shensa and Barrows (1932) is the most reasonable to date.

The following experiment conducted with leech material is essentially the same as that described by Shensa and Barrows for the earthworm. In this report I will not repeat details of the experiment, as these have been previously reported by the above authors. I will, however, briefly explain the principle of the experiment, the results and the application to the explanation of the leech behavior.

The purpose of this experiment was to determine the relationship between the subepidermal nerve plexus and the lateral muscular contraction of the leech following lateral electrical stimulation.

A strip of the lateral body wall of the leech was removed. This strip of tissue consisted of the epidermis and muscles of the circular and longitudinal series, but did not contain any part of the ventral nerve cord. This strip was suspended in a tumbler of tap water. On each side of the strip were suspended parallel strips of copper screening which served as electrodes. The lower end of the strip of tissue was fastened to a stationary arm, the upper end to a movable writing arm of a kymograph lever A lever registering time in seconds and another to indicate the current change were placed against the smoked paper of the kymograph drum.

With the negative current applied on the skin side and the positive current on the muscle side, the strip of tissue contracted. Reversing the poles of the electrodes the strip of tissue showed a gradual relaxation.

The same strip of tissue was treated with novocaine after which it was attached and stimulated as before. No muscular contraction could be detected The same narcotised strip when stimulated directly, that is by attaching a fine copper wire to both ends, responded by definite contraction.

I have shown in the above experiment that the subepidermal nerve plexus exercises the same control over the circular and longitudinal muscles as previously demonstrated for the earthworm, and that this phenomenon explains the behavior of the leech to lateral electrical stimulation.[2] It gives definite evidence of the role played by the subepidermal nerve plexus in annelid behavior.

SUMMARY.

1. Anterior, posterior, and lateral electrical stimulation of the leech and earthworm resulted in identical reactions.

2. Dorsal ventral electrical stimulation of the leech and the earthworm resulted in quite different responses.

3. These differences in behavior are explained on the basis of neuro-muscular differences between the two types of animals.

4. Dorsal ventral electrical stimulation results in a definite orientation in the leech.

5. This orientation is the result of direct motor stimulation (i. e., without intervention of neurons in the nerve cord) on the muscles of the body wall through the subepidermal nerve plexus.

6. Experimental evidence obtained here substantiates the postulated polarity of motor neurons in the leech.

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[2]A detailed explanation of the influence of electrical stimulation and an explanation of certain phases of leech behavior will appear in a later issue of this Journal.

THE CENTENNIAL CELEBRATION OF THE COLLEGE OF MEDICINE OF THE OHIO STATE UNIVERSITY.

On March first, second and third, the one hundredth anniversary of the College of Medicine of the Ohio State University will be celebrated. The college is a direct descendent of the Willoughby College of Medicine, founded at Willoughby, Ohio, in 1834 This college later moved to Columbus, still later changed its names to Starling Medical College, and eventually was incorporated into the Ohio State University.

A comprehensive and appropriate program has been arranged by the committee under the chairmanship of Dr. Ernest Scott. The morning of March first will be given over to clinics by the staffs of St. Francis and the University Hospitals. In the afternoon there will be demonstrations by the laboratories in Hamilton and Kinsman Halls A banquet in the evening will be followed by a historical program in the Chapel, at which the speakers will be Dr. Packard, the Editor of the Annals of Medical History, Dr Forman of Columbus, and Dr. Rightmire, the President of the University. Dean Upham will preside.

On March the second at 10 30 A. M. there will be held a special convocation, with all the appropriate academic dignity, at which Dr. Henry S. Houghton will deliver the address. Presentation of honorary degrees will be made to several outstanding medical men. At this convocation will be delegates from various medical colleges, learned societies, and other institutions.

In the afternoon of March second, addresses will be made by Dr. Francis Carter Wood on Cancer, Dr. Edward Francis on Tuberculosis, and Dr William S. McCann on Metabolism. On this day the class reunions and the fraternity banquets will take place.

On March third, there will be medical and surgical clinics held by specialists from out of the state, and in the evening a public address by Dr. Charles Emerson sponsored by Alpha Omega Alpha.

All alumni and friends of the College of Medicine are invited to attend these ceremonies.

L. H. S.

BOOK NOTICES

Biometric Principles.

This is an excellent introduction to the principles of biometric analysis Proceeding on the admirable assumption that biologists need a conviction of the usefulness of biometric formulae and a knowledge of the fundamental assumptions involved rather than a mathematician's detailed training, the author develops logically the underlying principles of biometry "Normal" curves and their statistics, tests for goodness of fit, correlations, predictions, and errors of sampling are all discussed in a lucid and practicable manner. It is to be hoped that Part II of this work will be speedily available —L H S

Outlines of Biometric Analysis, Part I, by Alan E Treloar. 65 pp. (mimeograph). Minneapolis, The Burgess Publishing Co , 1933 $1.65.

Great Men of Science.

It is not often that a historical biography of scientists is of a truly readable nature, even to other scientists The material is apt to be either tiresomely technical, or else to consist of useless and superficial personal idiosyncrasies This book, however, may lay claim to being a masterpiece The story of the development of the sciences and of the men who made the development possible is strongly and consistently woven The book will repay careful reading, and the reading will not be a chore —L H S

Great Men of Science, by Philipp Lenard xxii+389 pp. New York, The Macmillan Company, 1933

British Economic Grasses.

An interesting volume containing keys to 57 British economic grasses Two keys are presented, one based on the external vegetative structures, the other on the anatomy of the leaf blade and sheath Of the 57 forms dealt with, 49 are reasonably abundant in eastern North America, many of them being the common grasses of our lawns and pastures Since the keys in the ordinary manuals are based on reproductive structures, this volume would be valuable to anyone attempting to identify the grasses of lawns and closely grazed pasture lands

W H Cami

British Economic Grasses, by Sidney Burr and Dorothy M Turner 94 pp , 111 figs. New York, Longmans, Green & Co 1934. $3 75.

Animal Biology.

Professor Wolcott of Nebraska has produced here a textbook which deals with a wider range of subjects than either Zoology textbooks which review a series of type forms, or the typical "biology" text which fails to satisfy the requirements for a standard college zoology course It is a modification of these two types in which the subject is developed in a logical way, presented in five parts, which contribute to the adaptability of the book

The author has made a definite attempt in Part I to state and illustrate the general principles and their applications within this field The body of the text is concerned with a review of the animal groups, in which much more than usual is included on life histories, behavior and environmental relationships The last fourth of the book deals with general considerations of ecology, evolution, and a whole series of related problems.

The text is well illustrated with many original drawings. The style is clear, forceful and concise. Many common misconceptions are stated as such and ruled out Behavior is placed on a stimulus-response basis Statements are unusually if not entirely free from teleology. Above all, the student is made to feel that the animals being discussed are alive. A useful glossary of terms precedes the index

This book should receive the attention of those presenting general survey courses as a text which presents a wide range of material in a clear, dynamic way, understandable to the student with normal preparation.—JOHN W. PRICE.

Animal Biology, by Rob't H. Wolcott. xvii+615 pp., 335 fig. New York, McGraw-Hill Book Co., Inc., 1933. $3.50.

Hunting Dinosaurs.

These two books belong together, as the second is a sequel to the first. They are the autobiographical account of the author's experiences as a collector of fossils. The man, Charles H. Sternberg, started life in 1850 in New York, moved West in 1865 when his father became principal of a College in Iowa, and two years later went to his brother's ranch in Kansas. Although he was lamed in a youthful accident he early became interested in the collecting of fossils and minerals. This interest became his one aim in life when at the age of seventeen he decided (much to the disgust of his father) to devote himself to that pursuit. His first serious collecting was of fossil plants from the Dakota group. From this he "graduated" into collecting fossil vertebrates, for the most part. The years between 1867 and 1907 brought him into personal contact with such leaders as Leo Lesquereux, the paleobotanist, E. D. Cope, Karl von Zittel, S. W. Williston, Henry Fairfield Osborn, and the great rank of vertebrate paleontologists of that time He collected for and with them, covering most of the West, visiting known collecting areas or discovering new ones. These contacts enliven the books and give insights into these men. The second book covers his experiences from 1909 to 1917 during which time he was collector and chief preparator for the Geological Survey of Canada. Since then he has "retired" to California although still actively collecting. (I had a letter from him this past spring offering fossils for sale.)

We often read with pleasure the life of a game hunter. Let us try the life of a really big game hunter. Here is an opportunity to obtain a better insight into the trials and tribulations of hunting fossil "big game" Now and then the author diverges from the course of events and draws careful and detailed "word pictures" of scenes from out of the geologic past, clothing the land with plants and filling the sea, air, or woods with the proper animals. The books leave one with a renewed wonder at what has passed and a great respect for one of the oldest and earliest collectors His collections are now found in most of the great museums of the world

The chronological order of events is not strictly followed, and though jumping backwards and forwards in time is confusing The illustrations are all halftones and give the reader an idea of the animals mentioned and an idea of the difficulties encountered in collecting, especially in the earlier years of the work.

WILLARD BERRY

Life of a Fossil Hunter, by Charles H. Sternberg. 286 pp. San Diego, 1931 $1 75

Hunting Dinosaurs on Red Deer River, by Charles H. Sternberg. 261 pp. 1932 $1.75. (Published by Charles H Sternberg, 4046 Arizona St., San Diego, California).

Sixth International Botanical Congress.

Those interested in the botanical sciences are requested to note that the time of the Sixth International Botanical Congress has been changed The Congress will meet at Amsterdam, Holland, from September 2nd to September 7th, 1935.

THE OHIO JOURNAL OF SCIENCE

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CONCERNING THE JOURNAL.

The Board of Control of the OHIO JOURNAL OF SCIENCE wishes to make the following statement so that members of the Academy may be intelligently informed as to the place of the JOURNAL in the life of the Academy.

In 1900 the Biological Club of the Ohio State University began publishing the *Ohio Naturalist.* Some years later the *Naturalist* became the official organ of the Ohio Academy of Science, and was thus sent to each member. By 1915 the Academy had widened its scope to include other branches of science than biology and geology, and in recognition of this increasing activity the name of the journal was changed to THE OHIO JOURNAL OF SCIENCE.

Since then the JOURNAL has continued as an outgrowth of the *Ohio Naturalist*, serving continuously as the official publication for the Academy, and is now in its thirty-fourth year. It has welcomed and has promptly published articles in the various sciences other than the biological sciences. It has served as a repository for a large amount of information on the natural history and geology of Ohio. Its files present a fertile field for the worker in science who must know what has been done in the past in Ohio science

At present the Ohio Academy of Science pays approximately half of the cost of publishing the JOURNAL. The other half is paid for by the Ohio State University, supplemented by income from outside subscriptions, sale of back numbers, etc. Thus the cost of publishing the JOURNAL is more than double the price to the subscriber. More than 400 subscriptions and exchanges go outside the state of Ohio, the majority to foreign countries, so that the JOURNAL is widely distributed and internationally available.

The Ohio State University and the members of the Academy benefit from the foreign mailing list because many of them

constitute exchanges, putting expensive and valuable foreign journals on the library shelves where they are available to all members of the Academy.

Considerable prestige to the Academy results from the publication of the JOURNAL, since few other state Academies support as creditable a publication. The demand for back numbers is brisk, evidencing the desirable type of articles which it is the editorial policy to publish.

In helping to support any science journal the individual knows that only a small percentage of the papers published will be of immediate interest to him, but that without his co-operation none of the papers could reach the public There is doubtless as much of direct interest to the majority of the Academy members in the OHIO JOURNAL OF SCIENCE as there is in any of the national society journals.

As the Academy receives prestige and a convenient outlet for publishing from the JOURNAL, so the JOURNAL derives its very life from the Academy. Without the support of the Academy the JOURNAL could not hope to exist. The mutual benefit derived by the Academy (which in the last analysis means the individual members of the Academy) on the one hand and the OHIO JOURNAL OF SCIENCE on the other hand is not something to be lightly tossed aside.

SOME NOTES ON THE PLEISTOCENE HISTORY OF THE CINCINNATI REGION.

L S BRAND,
University of Cincinnati.

INTRODUCTION.

Dr. Leverett's paper, "The Pleistocene of Northern Kentucky,"[1] reports the work of a pre-Illinoian glacial advance in the region of Cincinnati. So far, it has not been correlated definitely with either of the earlier glacial stages. Dr. Leverett has outlined two small areas south and west of Covington, Kentucky, on the west Cincinnati quadrangle which are covered with a deeply weathered drift which he attributes to a pre-Illinoian glacier He considers that enough till is present in the glacial material and that the deposits show sufficient decomposition to warrant the interpretation that an ice sheet earlier than Illinoian pushed its way over the highest hills (up to 900'+ A. T) in that part of northern Kentucky, at least. This would be a happy circumstance in view of the presence of many large erratics scattered over parts of northern Kentucky beyond the boundary of the Illinoian ice Dr. W. R Jillson, who has reported many of these large boulders[2] has suggested that they were brought into Kentucky by a pre-Illinoian ice sheet, but Dr. Leverett's paper is the first to report boulder clay in Kentucky attributed to an early Pleistocene ice in that state.

It is the opinion of the writer of this paper that the glacial material described by Dr Leverett and attributed by him to the presence of an ice sheet, is water-laid instead of ice-laid, that it was deposited by flowing water rather than by ice. It is also believed that the outwash which covers most of the high land (above 800' A. T) in that part of northern Kentucky which appears on the two Cincinnati quadrangles and beyond the border of the Illinoian ice is probably of the same age and origin as that found in the very restricted areas outlined by Dr. Leverett. It is thought that the material was furnished

[1]Leverett, Frank. Kentucky Geological Survey, Series VI, Vol 31, 1929

[2]Jillson, W. R "Glacial Pebbles in Eastern Kentucky," Science, Vol LX, No 1544, 1924 "Glaciation in Eastern Kentucky," Pan Am Geol, Vol XLII, 1924. "Early Glaciation in Kentucky," Vol. XLIV, pp 17-20, 1925 Also Ky. Geol. Sur, Vol 30, 1927

by an ice sheet as well as by the northward-flowing rivers of Kentucky and that the record points to a period when the highest hills of that part of Kentucky were covered with water—glacial water from melting ice and river water which flowed into the region and had to flow away. The question of age seems to be a matter of some uncertainty. Certain facts make these deposits appear to be of pre-Illinoian age and other circumstances, as will be discussed later, make them seem more plausibly of Illinoian age.

In the area near Covington, there was seen by Dr. Leverett a 3–4 foot layer of boulder clay and another is reported by the present writer which was 8–10 inches thick, but which disappeared within a few feet laterally as the excavation was continued. Both were underlain and overlain by sand and gravel and surrounded on all sides at like elevation by the same sort of water-laid deposit. Neither had any important areal extent, as will be shown later. There was also noted on the surface at 900′+ A T. a sandstone boulder, perhaps 8 inches long and 5 or 6 inches thick. The boulder clay embedded in gravel is considered insufficient to justify the interpretation that northern Kentucky was overridden by a pre-Illinoian glacier The one boulder scarcely constitutes a difficulty

DESCRIPTION OF MATERIALS.

The glacial material southwest of Covington, Kentucky, mapped by Dr. Leverett as drift and till of pre-Illinoian age, varies considerably from place to place within a small area. In some places it is chiefly gravel, in others sand and in some places it is largely silt-like in character.

In an exposure where the material is mostly gravel, the pebbles in the upper 20–25 feet are much decomposed, many crumbling easily, and to the same depth the deposit as a whole is of a very dark brown color streaked with black along the cracks. The upper part is quite clayey, probably due to the decomposition of feldspar rocks, and has been used for molder's sand. A few chert and quartz pebbles remain. Lower down the pebbles are more solid and range in size from tiny ones to two or three inches in diameter. Many are undoubtedly of glacial origin. Such a deposit can be seen near Amsterdam road about three-quarters of a mile northeast of Ft. Mitchell. The highest elevation is 900′ A. T. by the topographic map and the deposit seems to slope down the

hillside to an elevation of about 820′ A. T., where it overlies a fine calcareous sand carrying many cemented masses of sand in concretionary form. It was a few feet above this sand at an elevation of perhaps 840′ A. T. that the thin band of boulder clay was seen by the writer. The band of boulder clay seen by Dr. Leverett was about a quarter of a mile south of this point exposed in a street excavation in the same ridge[3] Dr Leverett does not recall any other place where boulder clay was seen by him. The street excavation is now somewhat slumped and shows no boulder clay

It is hardly possible that it was the same lens of boulder clay which was seen in the two exposures, because it does not appear in a deep excavation (perhaps 25 feet vertically) between the two points. Neither band of boulder clay appears in two other exposures (30–40 feet vertically) at like elevation within a quarter of a mile to the east.

At other places at the same elevation (above 800′ A. T. and covering the highest hills which are about 900′ A. T.) the same dark brown, deeply leached deposit consists of sand, either coarse or fine and showing unmistakably horizontal bedding indicative of water as the agent of deposition. One mile southwest of Covington along the Lexington pike are two such exposures. The material is fine sand in the lower part and coarser sand and gravel toward the top One exposure shows 32 feet of sand and gravel and is leached of its lime to a depth of 23 feet. The leached portion is very compact and very dark brown except near the surface where the color is grayish. The other exposure is deeper, perhaps 40 feet, but is otherwise identical in appearance There is nothing in either that could be mistaken for boulder clay and they are within a quarter of a mile east of the ridge where the layers of boulder clay were seen, and at a like elevation

In Devou Park in Covington, much of the material is very silt-like, but it contains residual pebbles of chert near the surface, and layers of gravel and sand below show it to be water-laid also. The elevation is 860′ A. T. by the topographic map and the depth of the exposure is over 40 feet by measurement. It is not fresh enough to give a chance for actual measurement of the depth of leaching. The entire depth seems to be leached, but this is probably deceptive. This exposure

[3]Report of this location is contained in a private communication from Dr Leverett

was referred to formerly as loess,[4] but this view must be abandoned when one considers the sand and gravel present.

It is more or less irrelevant to the subject matter of this paper, but it seems improbable to the writer that any loess exists in the vicinity of Cincinnati, either north or south of the Ohio river. All the silt-like material found on the surface of the glacial mantle seems to contain residual pebbles and to grade downward into regular glacial material where the exposure is deep enough. The pebbles in loess-like material have been referred by some writers to the work of crawfish. This seems to the writer untenable as well as unnecessary. The pebbles are so uniform and constant in their distribution, that one is lead to doubt whether crawfish are sufficiently ubiquitous to account for them. At any rate, the decomposition of both gravel and boulder clay would yield a silt-like material near the surface, besides the residual pebbles.

On the weathered surface of all this mantle southwest of Covington, whether the material is mostly fine silt or sand or gravel, there are scattered an abundance of small pebbles. So many of these are of white quartz that one is reminded of the Pennsylvania conglomerate of Kentucky. One would expect that the Kentucky rivers would bring their load into such a ponded area, and to find Kentucky rocks mingled with those from Canada in the resulting deposits. This is probably the explanation. Of course, the quarts pebbles could also have been brought by the ice from the Pennsylvanian conglomerate of Ohio.

In addition to the water-laid material described above which is to be found within the areas marked by Dr. Leverett, there is to be found on most of the upland south of Cincinnati which lies outside the Illinoian ice border deposits of sand and silt, some of it gravelly. The highest level east of the Licking in the east Cincinnati quadrangle is around Cold Springs where the land rises to 880′ A. T. by the map. In many places on all this land over 800′ in elevation there is to be found sand or sandy silt or fine gravel, all decomposed, all dark brown and all stained to considerable depth with black. This tallies precisely with the major features of the deposits described above which are to be seen west of the Licking river. No deposits have been noted east of the river which are not leached of their lime.

[4]Fenneman, N M "Cincinnati and Vicinity," Ohio Geol Sur. Bulletin 19, 1916, p 138

However, no exposure is known to the writer where a sufficient depth is penetrated to find the unleached lower part, if it exists. Dr. Leverett infers on page 13 of his paper[5] that these sands east of the Licking are to be correlated with the Ohio River Formation of Tertiary age, but it seems to the writer that they are to be referred to the same conditions which are responsible for like material at a like elevation and with a like relation to drainage west of the Licking. These deposits, then, are also regarded as a part of the deposit due to Pleistocene flooding. Good examples for study can be found in Ft. Thomas near the intersection of Grand Avenue and Highland Avenue, along the road one mile east of Cold Springs, and near Alexandria, a few miles south of the border of the east Cincinnati quadrangle. It is shown also at many other places along the ridge roads in Campbell County.

West of the Licking river, too, and outside the areas outlined by Dr. Leverett are to be found deposits of brown sand on the high ridges. This can be seen in many places on the high land around Hebron, Kentucky, in the west Cincinnati quadrangle where wells are reported which yield soft water. Since this sand correlates in appearance and elevation with that to the east, it is probably of the same origin.

The sands and gravels here discussed occur generally on high land, usually above the 800′ contour. One exception to this rule deserves to be mentioned, where waterlaid deposits in this part of Kentucky occur at about 700′ A. T. On the little 700′ A. T. hill immediately east of Newport, Kentucky, on the east Cincinnati quadrangle is a leached deposit of fine sand resting on the bed rock It is about ten feet thick and shows horizontal bedding.

Sand and gravel showing horizontal bedding all over the highest land surface can mean only one thing and that is flowing water at that level, not necessarily and not probably at that great an elevation above sea level. Some sort of flooded condition must have maintained from which the water had to flow away. A melting ice sheet would furnish the proper kind of temporary flood and would furnish the Canadian rocks found in the gravels, while the rivers which naturally flow northward in Kentucky would add their quota to the foreign material brought by the glacier. Of the sand, further study

[5] Leverett, Frank, *loc. cit*

may show what part belongs to the northern and what to the southern origin.

If a flooded condition covered the 900′ contour south of Covington, it must have covered a wide area in Kentucky and one might expect to find water-laid deposits anywhere that was land surface after the flood receded and from which the material was not washed away either then or later. If the age shall prove to be pre-Illinoian, it is not known to the writer over which divide the accumulated waters discharged. A great area of north central Kentucky is now lower than 900′ A T If these deposits can be referred to Illinoian time, it is probable that the ponded water was poured through the col at Anderson Ferry.

One mile west of Cold Springs and three-quarters of a mile east of the valley wall of the Licking river is an exposure of boulder clay at the surface which merits attention. The elevation is 840′ A T. by the topographic map and the depth of the exposure is about five feet, though a little less than half of this can be said to be vertical and free from slump. All that can be tested is free of lime The material is very compact, but neither darker in color nor more decomposed in appearance than ordinary Illinoian boulder clay. The upper part is loosened by decomposition only to a depth of 12 or 18 inches, another circumstance which points toward its being of Illinoian age There are many small pebbles, chiefly of quartzite and one quartzite was found which was about three inches across At other places within a mile north of this point on the high level east of the Licking, glacial pebbles were found on the surface in plowed fields Though this is beyond the border of the Illinoian ice as mapped,[6] it is believed to be of Illinoian age and to occupy a significant position relative to the sand and gravel around Cold Springs

North of the Ohio river there is to be found some water-laid material on high land covered by till. At Kennedy Heights at an elevation of 840′ A T coarse water-laid sand is covered with a brown, leached boulder clay This can be seen well at the end of the Kennedy Heights car line at Kennedy Avenue and Montgomery Road The boulder clay there is about six feet deep, contains no lime and few pebbles. Two large quartzite boulders were found in place in an excavation about

[6]Leverett, Frank, *loc. cit*, p 15

ten feet deep. It is not known how much sand there is beneath the till. The excavation showed several feet.

This sand covered with boulder clay probably represents the ice which furnished the gravel for the deposits south of the Ohio which are discussed above. Unfortunately, the depth of the boulder clay is not sufficient for definite conclusions as to its age.

DEPTH OF LEACHING IN GLACIAL MATERIALS IN RELATION TO THEIR AGE.

All glacial materials which have traveled across the state of Ohio will have become limy When exposed to the weathering of rain water, the lime will be leached from the surface downward and the depth to which this leaching has been accomplished is the best indicator of the age, modified naturally by the kind of material. Laminated clays will be least readily penetrated, boulder clay next, and sand and gravel most readily The depth of leaching, then, will increase in this order for any given length of time.

The great depth of leaching shown in the glacial deposits southwest of Covington in addition to the decomposition of the rocks and the very dark color is the best criterion for recognition of great age

Wisconsin gravel at Red Bank in the eastern edge of Cincinnati shows a leaching of the lime to a depth of 55 inches and in a kame south of Hamilton, Ohio, the gravel was free of lime to a depth of 46 inches There is very little gravel of Illinoian age exposed at the surface near Cincinnati The outwash is in most places covered with boulder clay However, at Mariemont and Madisonville in the abandoned trough of the Ohio east of Cincinnati are places where gravel and not boulder clay form the top of the deposit An exposure along the road in Mariemont shows a lens of gravel at the surface with boulder clay on either side of it at the same elevation and all a part of the regular valley fill. It must represent the course of a stream on the ice. In this gravel it was found that the leaching has reached a depth of 14 feet from the surface. The color in the leached zone is dark brown streaked with black and the pebbles are decomposed quite like the deposits south of Covington. However, in the gravel and sand deposits along the Lexington pike, the leaching shows a depth of 23 feet from the surface. Since leaching must proceed more slowly with depth, this

may be a great enough difference to indicate that the age of the Kentucky deposits is pre-Illinoian.

REVIEW OF ILLINOIAN AND WISCONSIN GLACIAL HISTORY AT CINCINNATI.

Omitting for the moment consideration of the work of a pre-Illinoian glacier it may be well to review briefly the events of glacial history in northern Kentucky and southern Ohio which are more recent and therefore more clear. The water-laid deposits described above with one exception known to the writer are not lower than 800′ A. T., which seems to indicate that the drainage at that time was scarcely lower After that, presumably, and before Illinoian time, the streams were able to entrench themselves more than 400 feet below this level. Such a deep valley now abandoned and partially filled with glacial deposits can be seen northeast of the city of Cincinnati. It is about two miles wide with a rock floor at about 370′ A. T. and with walls rising sharply to 860′ or 880′ A. T. It was carved, no doubt, by the ancestral Ohio which carried during that time the Scioto and Kanawha drainage. The basin of Cincinnati in some parts and the valley of Mill creek west of the city have a rock floor of equal elevation and must therefore belong to the same period of active stream erosion. These valleys and others were partially filled with Illinoian outwash and boulder clay. This is evident in a definite terrace level along the present Ohio river and in the above-mentioned abandoned valley which is 600′ to 660′ A. T., the higher level to the north as one would expect. It consists of outwash capped with a variable thickness of boulder clay.

Some valleys east of Cincinnati were filled in the same way to a level of 700′ to 720′ A. T., as for example the valley of the Little Miami river north of Milford, Ohio, east Cincinnati quadrangle, the valley of East Fork, east of Milford, and the valleys of Dry Run and Cluff creek south of the Little Miami and southwest of Milford. It is not known how widespread this higher terrace is nor just how it correlates with the 600′+ A. T., terrace ascribed to Illinoian age.

It has been assumed that the Illinoian ice also overrode the hilltops in the vicinity of Cincinnati and a small area in northern Kentucky, because there is everywhere more or less of glacial material on the highest levels. This is in most places a thin veneer (three or four feet thick) in which case it is entirely

leached of its lime, contains few pebbles and these of chert, quartzite and basalt, and is remarkably silt-like in character. It does not seem to be loess, however, because of the constant occurrence of pebbles. Such a veneer can be seen at many places along the ridge road from Cheviot to Cleves in the west Cincinnati quadrangle. In other places the boulder clay on high levels is thick enough to show the typical Illinoian soil profile[7] with a high content of lime at about four or five feet from the surface. This can be seen, for example, in the C. & O railroad cut at Summit, one mile south of Westwood, in the west Cincinnati quadrangle or near Crescent Springs, Kentucky, also in the west Cincinnati quadrangle.

It seems certain that it was the Illinoian glacier which obstructed the northward course of the Ohio river at Cincinnati and caused ponded water to cut through minor divides east and west of the present city and so establish the present course of the Ohio from the mouth of the Little Miami river to the mouth of the Big Miami Such a conclusion seems justified from two lines of evidence, though another fact is hard to explain. Dr Leverett[8] says that the col at Manchester seems to have been cut through during a pre-Illinoian glaciation and that the great amount of water poured through the channel of the Ohio was able to cut the very deep and very wide valley northeast of the city of Cincinnati. This trenching with abrupt valley walls was accomplished before the advance of the Illinoian glacier The great width of the valley in contrast to the narrow abandoned curves of the river which originally headed near Manchester preclude the possibility of the former having been cut by the same stream as the latter. But the great amount of ponded waters added to the water of the Kanawha and Scioto systems is another matter and of a magnitude corresponding with the width of the abandoned valley. The lapse of time between the early ice which caused the Manchester divide to be broken and the Illinoian ice which caused the augmented Ohio to abandon its northward course toward Hamilton must have been considerable and the trenching during this time seems to have amounted to 400 feet, at least, near Cincinnati.

Another line of evidence which seems to date definitely this relative order of events along the Ohio river is the occur-

[7]Leighton, M M Journal of Geology, Vol XXXVIII, No 1. 1930.
[8]Leverett, Frank, *loc cit*, p 26

rence of water-laid coal and mica in a river terrace in the abandoned valley.[9] The level correlates with the regular glacial filling of the old valley (600' ± A. T.) and the sand in which the coal and mica occur is overlain with the usual capping of boulder clay The coal and mica must have come from the coal fields of eastern Ohio or Kentucky and the water which brought them must have flowed through the Manchester narrows. The Illinoian ice must have advanced from the north, constituting an obstacle which the water was unable to surmount.

Certain facts are hard to fit into such a picture of past events The Illinoian glacial fill in the abandoned curve toward Hamilton rises from about 600' A. T. at Cincinnati to 660' A T. north of Glendale in the Mason, Ohio, quadrangle. At Cincinnati, this is nearly 300 feet lower than the divide at Anderson Ferry, five miles west of Cincinnati, which was broken, presumably, in order to let the ponded water escape to the west. It is difficult to think that such a valley deposit is sufficient record for a front of ice which is to be credited with changing the course of such a great stream and causing its waters to spill over a 900' ± A T , divide. If a real glacial dam was ever built up in this valley, what has become of it? How could the same glacier be responsible for an orderly valley deposit built of outwash covered with boulder clay, at 600'+ A. T., and for the boulder clay on the highest hills near Cincinnati (900'+ A. T)?

As to the absence of the glacial dam, another possibility presents itself. If the stream continued northward at Hamilton, Ohio, as has been stated by Tight and Fowke and Malott, instead of southwestward, as believed by Dr Leverett and Dr. Fenneman, the dam may be considered to lie north of Hamilton where much of the original topography is, no doubt, covered with drift

After Illinoian time, a period of trenching followed before the advance of the Wisconsin glacier to within five miles of Cincinnati on the north All valleys which were low enough to receive it were filled with outwash to a level of 530'–560' A T.

Since Wisconsin time, the drainage has been carried to a lower level than this outwash, so that both these glacial deposits are to be seen as dissected terraces in most of the big valleys around Cincinnati.

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[9]Brand, L S "The Occurrence of Coal and Mica in Pleistocene Deposits near Cincinnati," Ohio Journal of Science, Vol XXXII, 1932

South of the Ohio river at Cincinnati there are the typical Illinoian deposits in the valleys east of the mouth of the Little Miami river and on the uplands as well, both east and west of the Licking in that area over which the ice advanced. As outlined by Dr. Leverett, this border shows a deep indentation to the north at the mouth of the Licking As far as known to the writer, there are no alluvial terraces along the Licking river which correlate with the 600′ outwash of Illinonian age north of the Ohio river. Such terraces of Wisconsin age are a distinct feature and correlate perfectly with the 530′ A. T., Wisconsin outwash level at Cincinnati. The absence of such alluviation during Illinoian time may mean that the Licking was not there then. This opinion was presented by Louis Desjardins of the University of Cincinnati in a paper given before the Kentucky Academy of Science in 1931. It has been assumed by Dr. Leverett and Dr. Fenneman, however, that the Licking flowing northward carved the pre-Illinoian valley directly west of Cincinnati which is now occupied by the Mill creek flowing southward. In that case the valley south of the Ohio river must have been cleared since that time

AGE OF KENTUCKY DEPOSITS

Definite conclusions concerning the age of the high-level outwash in northern Kentucky probably await further field observations. If one is inclined to consider these deposits as of pre-Illinoian age, certain facts seem to substantiate that position.

1. The Kentucky sands and gravels are leached, decomposed and discolored to a greater depth than those of known Illinoian age also exposed at the surface. The difference appears to be a matter of depth alone, however, as the discoloration, the decomposition of pebbles, and the clayey content in the upper part appear the same in both.

2. The Kentucky deposits are limited to the highest levels. If deep valleys had existed at the time of this deposition, it is difficult to see how later erosion could have been so selective as to leave the material only on the high levels. It is certain that valleys as deep as 370′ A. T. had been carved before Illinoian time, because such valleys were filled with Illinoian deposits. Such reasoning would seem to date these high-level sands and gravels as pre-Illinoian and to make them correspond in age with a topography older than the valley sides

3. As above stated, the deposits under discussion are water-laid and higher than 800′ A. T. The Illinoian terrace is also for the most part outwash with an upper limit of 600′ ± A. T. at its southern edge. It seems inconsistent that two definite levels for water-laid material could have been developed in the same glacial period with a difference in elevation of 200′. It would be more convenient to account for such discordant levels by referring the higher to an older glaciation. And again, if the Illinoian glacier has left a clearly-marked outwash level which is nearly 300 feet lower than the old Anderson Ferry col, as before noted, it is hard to suppose that such waters could have broken the divide. However, the present valley of the Ohio at Anderson Ferry is so narrow and steep-walled that it can not be referred to any very ancient time. If the sands and gravels near Covington are to be correlated in age with the cutting of the Anderson Ferry divide, it would serve to indicate the youth of both rather than the great age of both

However, there are four more circumstances which should be pointed out in considering the age of these Kentucky deposits. After these considerations are weighed, it seems to the writer not impossible that the high-level sands and gravels near Covington may prove to be of Illinoian age, after all.

1 The deposits are largely sand and it is believed that some of it has been carried a considerable distance by flowing water Some of it may have flowed south only to be gathered up and carried northward again Sand that has traveled far would be partially leached, at least, when it was deposited. This may be a factor in accounting for the greater depth of leaching in the sands and gravels in Kentucky than in like material of Illinoian age in Madisonville and Mariemont. Besides, the difference is not as great as one would expect (23 feet in the former and 14 feet in the latter), considering the great length of time which is ascribed to the interglacial period which preceded the Illinoian advance

2. Drainage would be more perfect, the water table would sink lower, and leaching would proceed faster in gravel or sand on high land than in a like deposit on low land. The Illinoian gravel at Mariemont is not higher than 600′ A. T. with the old valley wall rising to 880′–900′ A. T. immediately above it. That on the Lexington pike is at an elevation of 900′ ± A. T., the highest level, thereabout.

3. The ridge of coarse gravel southwest of Covington lies

just where the Licking would have helped build it, if when the Illinoian ice covered the hills to the northeast and to the northwest it had continued to discharge its waters into the re-entrant angle. The angle between the two scallops in the ice border[10] besides the unusual coarseness of the material near the mouth of the Licking suggests this relation. The Anderson Ferry divide must have been almost 900′ A. T. and it is the Illinoian flood which is credited with breaking it Just upstream from this old divide and near the mouth of a strong northward flowing stream (the Licking) is exactly where such coarse waterlaid material would have been lodged before the divide was actually broken.

4. The smaller area of drift mapped by Dr Leverett as pre-Illinoian (about a mile and a half north of Crescent Springs) and also the high-level sands around Hebron reported in this paper are north of the border of the Illinoian ice If these sands and gravels are of early Pleistocene age, it is difficult to picture how the Illinoian ice could have overridden such horizontal and unconsolidated beds without either disturbing them or leaving any boulder clay on top. If the water which deposited the sands and gravels be thought of as contemporaneous with the thinning edge of the ice which left the boulder clay, the picture is less confusing Dr. Leverett says,[11] "It is a singular circumstance that its apparent south limit and that of the Illinoian drift should be so nearly coincident "

ROCK BENCHES IN THE VICINITY OF CINCINNATI.

Since the sands and gravels discussed here are restricted to high levels, it probably means that at the time of their deposition only those areas were above the drainage lines, which furnishes a strong inference that their age is pre-Illinoian. If we omit the Newport sand at 700′ A. T. which will be referred to again, the deposits described in this paper occur only above 800′ A. T. This would indicate that at that time the drainage was relatively over 400′ higher than the present major streams.

This level is in accord with the elevation of the highest and most prominent rock bench in the Cincinnati region both north and south of the Ohio river. At a glance over the two Cincinnati quadrangles, one is struck by the flat areas inside terrace-like loops of the 820′ or 840′ contour. This level is

[10]Leverett, Frank, *loc cit*, p 15.
[11]Leverett, Frank, *loc. cit*, p 41.

even more striking in the field. It can be seen well, for example, all over Devou Park west of Covington where the 820′ level makes finger-like projections toward the Ohio and Licking river valleys. East of the Licking, too, the valley wall rises steeply to about 840′ A. T. where a marked level is apparent. It can also be seen around Dent, three miles northwest of Westwood or along the Ohio river east of the Little Miami river. These last two places are about twenty miles apart, so the level cannot be attributed to any stratigraphic dominance, because the strata rise eastward, at least three or four feet per mile toward the axis of the Cincinnati arch which crosses the Ohio river about 25 miles east of Cincinnati. The Bellevue member of the McMillan formation at Cincinnati has a total thickness of 15 to 25 feet and is not hard to recognize. The level of the top of the Bellevue at the University of Cincinnati is approximately 800′ A. T. Near Dent at a distance of eight miles northwestward from the University the base of a Bellevue outcrop was found by aneroid to be 753′ A T. If the measurement was accurate this would show a rise of three or four feet per mile in a southeastward direction. It is probably a little greater in a more nearly eastward direction This 800′-820′ bench is also prominent north of Madeira, near Montgomery, around Reading and in other places in the northern part of the east Cincinnati quadrangle as well as south of the Ohio river in the extreme western part of the west Cincinnati quadrangle. These areas are also separated by as much as twenty miles. Such a level must be older than or of the same age as the Pleistocene water which flooded it and everything higher in this immediate vicinity.

Following this glacial advance which may have been partially responsible for depressing the land surface, there seems to have occurred uplift, possibly due in part to the withdrawal of the load. This causal relation is only a conjecture. The streams evidently entrenched themselves more than 400 feet before the Illinoian advance, but this was accomplished apparently with two interruptions. A second rock bench at about 700′ A. T. is too marked to be missed and another at around 600′ A. T. is less clear but unmistakably a marker for some sort of halt in rejuvenation.

The level of each of these rock benches correlates so closely with evidence of glacial outwash at that level, that the coincidence may be more than accidental. Uplift may have been

checked or actual depression brought about in each case by the advance of an ice sheet and rejuvenation quickened by uplift as the ice withdrew and its load of water was discharged through old or altered drainage lines. The period of outwash building would be a time when a great volume of water was being handled by the drainage and when a great supply of cutting tools was available.

At any rate a marked rock bench is clear in the field or on the map which is around 700′ A T. and, as said before, there is also a level-topped glacial terrace in the valleys east of Cincinnati which is largely outwash, capped with boulder clay. It is not known to the writer how extended this 700′ A. T., glacial terrace may be found to be and it is only conjecture that it bears any relation to a rock bench of that elevation.

The 700′ A. T., sand at Newport, mentioned earlier, lies on a rock bench and is probably to be assigned to this time of glacial outwash.

In Cincinnati the suburbs of Clifton, Hyde Park, and Avondale are largely built on a 700′+ A. T. bed rock level and overlooking many valleys are prominent 700′+ A. T. spurs. Near Miamitown in the western part of the west Cincinnati quadrangle are good examples and along the Ohio river near Cleves and Addyston. The long spur extending toward the Ohio river between Ludlow and West Covington is another excellent example.

This relation is suggested again in the correspondence between a less widely developed rock bench at an elevation of about 600′ A T. and the level of the glacial fill in the abandoned valley of the pre-Illinoian Ohio In both Cincinnati quadrangles it will be found that most of the 600′ A. T. loops in the contours represent glacial material, but in several cases these benches are of bed rock. In one case known to the writer, a single topographic bench is in part bed rock and in part sand. It is between Bellevue and Newport, Kentucky, a 600′ A. T. spur known as the Spinx subdivision. Just west of the suburb of Clifton in Cincinnati there is a prominent ridge extending northwestward toward Cumminsville which is a bed rock bench with glacial material abutting against it. In West Covington there is a small abandoned oxbow of some earlier drainage which carved its stream bed only as deep as 600′ A. T. before it was diverted. There is a 680′ A. T. hill between the bed of the oxbow and the Ohio river on the north. At John's

Hill, about two miles south of Newport, is an abandoned tributary valley at 600′ A. T. The record of drainage at 600′ ± is largely obscured north of the Ohio river by the fact that glacial deposits are of the same elevation. It is possible that this lowest rock bench bears the same relation to the 600′ A. T. Illinoian outwash as that outlined above for the 700′ A. T. bench.

On the other hand it is possible that the two lower benches were cut during a halt in regional uplift due to other causes and that all the glacial outwash came later and bears no relation to the rock benches. However, if the Lake Champlain region has risen 400 feet since the withdrawal of the ice, presumably in response to the removal of load, it does not seem too fanciful to the writer to suppose that the area around Cincinnati may have had its regional uplift interrupted as above conjectured by advancing and retreating ice.

GLACIAL ERRATICS IN KENTUCKY.

Glacial boulders have been reported at many places in northern Kentucky beyond the border of the Illinoian ice, and some of enormous proportions and in baffling topographic positions Those west of the Licking river are near enough the main drainage lines and low enough in elevation to offer no difficulties in view of the 900′ A. T. gravel near Covington. The largest and the highest are those in the district of the knobs and coal fields of eastern Kentucky. This is in an area south of the old divide at Manchester, Ohio, extending into Lewis, Rowan, Carter, Elliot, and Morgan Counties A particular boulder at Epworth in Lewis County is reported by Dr. Jillson to be 986′ above sea level and is estimated to weigh 16 tons. A good many others have been reported in that section at around 850′ A. T. One at Farmers in Rowan County weighs about three tons. It is because of these erratics that Dr. Jillson suggested that other evidence of a pre-Illinoian ice sheet in Kentucky might be found, but he reported no boulder clay or other evidence himself.

It seems to the writer of this paper that these erratics, lying as they do just where blocks of ice might have rafted them before the Manchester divide was broken constitute no insurmountable difficulty in the sequence of events. Dr. Leverett thinks the Manchester divide was broken at the time of a pre-Illinoian glaciation by the escape of flooded waters through a col. He thinks, however, that the divide at Man-

chester was not over 850′ A. T. and so the Epworth boulder in particular could not have been rafted to its present position. If it was not carried to the knob where it now is by a floating block of ice, then an ice sheet must have been responsible for the work. However, no boulder clay or other evidence of the presence of an ice sheet has been reported for that part of Kentucky. It seems impossible that an ice sheet capable of carrying such enormous boulders could have over-ridden the region without leaving any other record.

The water-laid material at 900′ A. T. near Covington reduces to 86 feet the discrepancy between the altitude of the highest boulder and other water-laid deposits along the Ohio river. If the outwash near Covington is of pre-Illinoian age, it seems probable that this region was at a lower altitude at the time of this flooding than at present and that the amount of uplift since that time may have been as much as 400 feet. In such an uplift it would be odd if there were no differential shifting of relative elevations over an area as extended as that with which we are dealing (70–75 miles).

It is, therefore, the opinion of the present writer that it is within the range of possibility for the Epworth boulder to have come past the Manchester narrows in a block of ice and that the position of it and of the others on the eastern knobs appears to be a clue to this explanation. At least until further evidence is produced no one can consider that they have been transported by an ice sheet which seems to have left no boulder clay either on the hills or in the valleys. If it is there, we ought to find it.

CONCLUSIONS.

Most of the conclusions in this paper are qualified with alternative possibilities and may be altered after further observations. It has been thought not unprofitable, however, to add the field observations to those reported for the region with the recognition that much more field work is needed before a satisfactory chronology of events can be certain.

1. It is believed by the writer that evidence of a pre-Illinoian ice sheet in northern Kentucky is still lacking—that the glacial material on the uplands south of Cincinnati is water-laid and not icelaid. It seems clear that the material was furnished by an ice sheet (Illinoian or pre-Illinoian) and also by the northward flowing rivers of Kentucky.

2. The sand and sand-and-gravel deposits which occur on most of the land surfaces which are higher than 800′ A. T. in the part of Kentucky which appears on the two Cincinnati quadrangles are thought to correlate in age and manner of deposition. It is thought that all these deposits covering a considerable area are to be referred to Pleistocene damming and that the deposits mapped by Dr. Leverett southwest of Covington are only a part of a more extended area of deposition.

3. The small amount of boulder clay seen imbedded in 30–40 foot deposits of gravel southwest of Covington is thought to have been rafted to its position by water also. The boulder clay is thought to have insufficient areal extent to be significant and entirely too little either vertically or horizontally to represent the spread of an ice sheet.

4. The silt-like material in Devou Park near Covington is reported to have gravel and sand layers and to contain many residual pebbles. It is believed that neither it nor any other deposit near Cincinnati can be called loess The great numbers of residual pebbles which all the loess-like silt contains seem to preclude wind as the agent of deposition. It is thought to be due to the decomposition of glacial material into which it grades downward.

5. Waterlaid sand at 840′ A. T. at Kennedy Heights overlain by a decomposed boulder clay is reported.

6. A glacial terrace is reported which is 700′–720′ A. T. instead of 600′-660′ A. T. as in the abandoned valley of the old Ohio. Both terraces consist largely of waterlaid material in the lower part, covered with boulder clay. The higher terrace occupies the valleys of the Little Miami and the East Fork, north and east of Milford, Ohio, and the valleys of Dry Run and Cluff creek south of Milford.

7. Three rock benches are reported for this region which show a striking correspondence in elevation with three known stages of glacial outwash. The 820′–840′ A. T. bench is at the same elevation as the lower limit of the old-looking outwash in northern Kentucky. The 700′–720′ A. T. bench corresponds with the level of the higher glacial (Illinoian?) terrace referred to above and the 600′ A. T. bench which is less well developed is at the same level as the top of the Illinoian outwash in the southern part of the abandoned river valleys near Cincinnati. It is suggested that the advance and withdrawal of the load of ice may have had something to do with the halt and renewal

of stream erosion, besides furnishing a great volume of water heavily loaded with tools to do the cutting. An uplift of 400′ ± seems to have occurred between the earlier flooding and the Illinoian advance.

8. If the Manchester divide was broken in pre-Illinoian time, as Dr. Leverett thinks, by the escape of ponded waters, it seems not impossible that the large erratics which are to be found south and a little east were carried to their present position by floating ice blocks It is suggested that the uplift which followed may have been somewhat differential and that relative elevations have been altered. At least the evidence for an ice sheet seems to be missing.

9. Depth of leaching in gravels of Wisconsin and Illinoian age are reported and also for the glacial material southwest of Covington. The figures are about 4 feet, 14 feet, and 23 feet respectively. One would like the last figure to be larger to make the deposits in northern Kentucky more convincingly ancient. It is suggested that their position would fit the conditions which must have existed in Illinoian time, and that they may, after all, prove to be of Illinoian age. Certainty as to their age seems to depend upon further field observations.

Evolution.

It is widely recognized that the key to the evolution of the vertebrates lies in the study of fossilized skeletal remains The vertebral column, with its complex structure, its wide variety of types in both living and extinct forms, together with its evolutionary implications held the interest of the distinguished scholar and author of this volume, Mr. Gadow, throughout forty years of his life.

This posthumous volume, edited by J F. Gaskell and H. L H. H Green, discusses in detail the morphology of the axial skeleton and its ontogenetic and phylogenetic modifications in the first part of the book, preliminary to the systemic morphology of the vertebral column in Part II. The author analyzes the complicated mechanisms involved with an understanding born of a life-time study of this subject. He exhibits particular insight in determining homologous and analogous relationships A great mass of fossil evidence is illustrated and discussed, by which the reader may follow the long tortuous road in the evolution of the Tetrapoda.

The text is a scholarly treatise, comprehensive and masterful. It is well edited. The bibliography is extensive and is indexed in an unique and useful way. It should take its place as an authoritative and valuable reference for the paleontologist and the student of vertebrate evolution —JOHN W. PRICE

The Evolution of the Vertebral Column, by H. F. Gadow. xiv 356 pp. Edited by J. F. Gaskell & H L. H. H. Green. Cambridge, the University Press; New York, The Macmillan Co., 1933. $6.75.

A REVISION OF THE NORTH AMERICAN HOUSE WRENS.

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One of the most interesting and surprising developments of recent ornithological activity in Ohio is the discovery of a new subspecies of the house wren, *Troglodytes domesticus* (= *Troglodytes aedon*). We had so consistently taken for granted that the Ohio house wrens were identical with those from the Atlantic coast of the United States that until recently we had made no comparisons of pertinent material

The intensive investigations that Dr. S Prentiss Baldwin and his associates have for several years been conducting near Cleveland in northern Ohio made it desirable, a short time ago, to determine definitely the subspecific status of the northern Ohio house wrens. It was then that we discovered that there was no material in any museum that would settle this question. Not until a good series of breeding birds was collected under the direction of Dr Baldwin near Gates Mills, in Cuyahoga County, Ohio, where the Baldwin Bird Research Laboratory is situated, was it possible to make the necessary comparisons. An even superficial examination reveals that the Ohio bird is readily distinguishable from both the Atlantic Coast bird and that of the western United States.

The present study has been based primarily on the collections of the Cleveland Museum of Natural History and the United States National Museum; but in the gathering of the specimens necessary to work out the characters and distribution of this hitherto unknown subspecies we have been greatly helped by the authorities of several museums and by individuals as well. These include the American Museum of Natural History, the Philadelphia Academy of Natural Sciences, the Museum of Comparative Zoölogy, the Ohio State Museum, the Zoological Museum of the University of Michigan, the National Museum of Canada, and the Royal Ontario Museum; S. Prentiss Baldwin, J. H. Fleming, P. A. Taverner, L. S. Snyder, J. VanTyne, A. W. Butler, Gus. Langelier, John S. Campbell, S. E Perkins III, and C. A. Stockbridge.

The following synopsis sets forth the characters and distribution of the North American house wrens. Measurements have been taken as recommended in the recently published manual of the measurements of birds [1]

Troglodytes domesticus domesticus (Wilson)

Eastern House Wren

Sylvia domestica WILSON, Amer Ornith, Vol I, 1808 [after Sept 1], p v (description on p 129), pl VIII, fig 3 ([Eastern] "Pennsylvania," we designate Philadelphia as the type locality)
Troglodytes aedon VIEILLOT, Ois Amér Septen, Vol II, "1807" [May, 1809], p 52, pl CVII (no locality, except "l'Amérique Septentrionale" in title of book; restricted to "Eastern United States," in American Ornithologists' Union Check-List North Amer Birds, Fourth Ed, October 1, 1931, p 242, we now designate New York City as type locality, whence Vieillot is known to have obtained ornithological material
Troglodytes fulvus NUTTALL, Man Ornith U S and Can [Vol I] Land Birds, 1832, p 422, (Bonaparte MS) (based on the breeding bird of the "Middle States" of the United States, we designate Philadelphia as the type locality).
Troglodytes americana AUDUBON, Birds Amer, folio, Vol II, 1833 [about December], Pl CLXXIX, Ornith Biog, Vol II, 1834 [after December 1], p 452 ("Dennisville" [Maine], type apparently lost) (nec *Troglodytes americana* Lesson, which, however, is a nomen nudum)
Troglodytes sylvestris GAMBEL, Proc Acad Nat Sci Phila, Vol III, for October [about Nov 20], 1846, p 113 (nom nov pro *Troglodytes americana* Audubon).

SUBSPECIFIC CHARACTERS.—Colors, especially on the upper parts, sides, and flanks, rufescent and moderately dark; middle of lower surface usually washed with dull buff.

MEASUREMENTS—Male. Total length,[2] 117 5–133 5; extent of wings,[2] 165–177 5; wing, 49.5–53 5 (average, 51 3) mm.; tail, 42–45.5 (44.2); exposed culmen, 11.5–13 5 (12.4), tarsus, 16.5–17.5 (17), middle toe without claw, 11–13 (12 2).

Female· Total length,[2] 108–117, extent of wings,[2] 155-171 5; exposed culmen, 11-12.7, tarsus, 16-18 (16 8); middle toe without claw, 11–13 (12 1) mm.

TYPE LOCALITY.—Philadelphia, Pennsylvania.

GEOGRAPHIC DISTRIBUTION.—Eastern United States and parts of southeastern Canada. Breeds north to northern New Brunswick, northern Maine, central New Hampshire, Vermont, and central New York; west to central New York, central Pennsylvania, western Virginia and western North Carolina; south to central South Carolina; and east to central South Carolina, central North Carolina, eastern Virginia, Northeastern West Virginia and the Atlantic Coast region north to Nova Scotia. Winters from Georgia, southern Louisiana, and southeastern Texas, south to southern Florida, and to southern Tamaulipas in Mexico. In migration occurs west to western Michigan

REMARKS.—This, the typical form of the species, is the most rufescent of the races. By the separation of the bird from Ohio and surrounding

[1]Measurements of Birds, by S Prentiss Baldwin, Harry C Oberholser, and Leonard G Worley, Scientific Publications of the Cleveland Museum of Natural History, Vol II, October 14, 1931

[2]Measured in the flesh by the collector.

areas as a distinct subspecies, the range of *Troglodytes domesticus domesticus* is in summer restricted chiefly to the Atlantic portions of the Eastern United States.

The specific name, *Troglodytes aedon* Vieillot,[3] by which this species has long been known, seems to be antedated by *Sylvia domestica* Wilson,[4] which was based on the breeding bird of eastern Pennsylvania. The former name occurs in the second volume of Vieillot's 'Oiseaux d'Amérique Septentrionale,' which has commonly been cited as published in 1807, the date of the title page. This work, however, it is now known, was published in monthly parts of six plates each, with accompanying text, and the first part appeared in December, 1807. Since *Troglodytes aedon* occurs in the second volume in the text to plate 107 (there are only 124 in the whole work) it could hardly have appeared before May, 1809. Therefore, as Wilson's *Sylvia domestica* was published late in 1808, Vieillot's name ought apparently to be replaced by Wilson's, and the species be called *Troglodytes domesticus*.

The name *Troglodytes americana* Audubon[5] was based on the breeding bird of Eastern Maine, which is the Eastern house wren. A specimen in the United States National Museum has been considered the type, and as such has appeared in print. It bears on its label the following inscription in Baird's handwriting: "Troglodytes americanus' Aud. 2951." On the back of the label in Robert Ridgway's writing are the words "Type of T. americanus Aud." An examination of this bird reveals that while it was a specimen given by J. J. Audubon to Spencer F. Baird, it is not a summer bird such as was the bird from which Audubon made his drawing, but is in fresh autumn or winter plumage, and apparently was one of the specimens later obtained by Audubon at Charleston, South Carolina.[6] A careful comparison of this supposed type with the plate of *Troglodytes americana* in the folio edition of Audubon's Birds of America, clearly shows that it is not the same, but is really an example of the Ohio house wren hereinafter described! Baird evidently did not consider it the type; in fact, he even questioned on the label its identification as Audubon's *Troglodytes americana*. This specimen is thus evidently *not* the type of *Troglodytes americana* Audubon.

Details of the distribution of *Troglodytes domesticus domesticus* at all times of the year may be gathered from the following list of localities from which specimens have in the present connection been examined.

Connecticut.—New Haven (May 9, 1888, May 21, 1878; Sept. 29, 1892); Litchfield (June 4, 1891), Stamford (July 3, 1890); North Milford (July 3, 1892); Sales Ferry (June 28, 1899); East Hartford (May 2, 1891); Windham (May 12, 1902; Sept. 16 and 17, 1891); Newtown (Sept. 23, 1880; Oct. 14, 1881); Fairfield Co. (May 28, 1904).

District of Columbia.—Washington (April 28, 1883; April 28 and 30, 1890; April 20, 1860; May 7, 1889; May 8 and 10, 1891; May 2, 1869; May 1, 1860; June 12, 1858; June 19, 1874; June 19, 1889; July 17,

[3] Ois. Amér. Septen., Vol II, "1807" [May, 1809], p 52, pl. CVII.
[4] Amer Ornith., Vol. I, 1808 [after Sept. 1], p v, pl. VIII, fig. 3.
[5] Birds Amer, Vol II, 1833 [about December], pl CLXXIX.
[6] Ornith Biog, Vol II, 1834, p 452.

1858; July 26, 1888; July 28, 1889; Aug. 19, 1889; Aug. 31, 1896; Aug. 12, 1887; Sept. 9, 1893; Sept. 23, 1889; Sept. 14 and 30, 1894).

Florida.—Gainesville (March —, 1882; Feb. 7, 1890); Miami (Jan. 7 and 18, 1871); East Peninsula opposite Micco (March 5, 1889); Manake, Miakka Co. (Jan. 22 and 23, 1900); San Sebastian (April 7, 1892); Kissimmee (March 4, 1895; Jan. 21, 1901); Cape Sable (Feb. 15, 1918); Trafford (Feb. 5, 1898); Royal Palm Hammock (Jan. 24, 1918); Cape Florida (Oct. 23, 1857); Hibernia (Feb. —, 1870); Brevard Co. (Feb. 25, 1905).

Georgia.—McIntosh Co. (Jan. 7, 1890).

Indiana.—Wheatland (April 27, 1883).

Louisiana.—Pecan Grove (March 9, 1890); Hammond (Nov. 21, 1875); New Orleans (Nov 2, 1882).

Maine.—No further locality (Spring, 1839).

Maryland.—Marshall Hall (June 6, 1892); Cornfield Harbor (July 24, 1894); Silver Spring (April 29, 1889), Kensington (Sept. 15, 1894; Sept. 15, 1895).

Massachusetts.—Middlesex Co. (May 3 and 18, 1883); Belmont, Middlesex Co. (May 6, 1875; May 6, 1879); Cambridge (June 2, 1892, June —, 1868); near Cambridge (April 23, 1880; May 17 and 31, 1889; June 1, 1892); Brookline (May —, 1857, June 5, 1897); Quincy (June 5, 1879); Medford (June 3, 1890); Watertown (June 16, 1869); Cohasset (no date); Springfield (May 25, 1863); Waltham (June 3, 1874; June 4, 1887).

Michigan.—Kalamazoo (May 27, 1875).

New Jersey.—Duck Island (June 26, 1895); near New York City (June 7, 1890); Crosswicks (Aug. 26, 1895); West Orange (Jan. 13, 1894); Summit (May 13, 1898); Lakehurst (June 6, 1907); Plainfield (April 26, 1871; May 9 and 31, 1871), Pocantico (May 22, 1891).

New York.—Oyster Bay, Long Island (June 24, 1878, May 24, 1874); Glen Cove, Queens Co. (Sept. 8, 1895); Shelter Island (May 18, 1892; Sept. 16, 1887), Staten Island (Aug. 1, 1907); Kiskatom (Aug. 28, 1889); Sea Cliff (July 4, 1904); New York (May 3, 1887, May 14, 1884; Aug. 12, 1890; Sept. 8, 1898; Oct. 1, 1896); Schroon Lake (Sept. 9, 1882); Highland Falls (May 4, 1883, Aug 9, 1878); Lewis Co. (June 2, 1884); Pearsalls (Nov. 3, 1891).

Ohio.—Cleveland (May 19, 1933).

Pennsylvania.—Gallitzin (June 20, 1890), Altoona (June 19, 1890); Carlisle (June 12 and 24, 1843; July 23, 1844; Sept. 16, 1842); Saltillo (July 9, 1895), Mercersburg (June 20, 1895); Bainbridge (no date).

Rhode Island.—Near Providence (May 14, 1897).

Texas.—Brownsville (Jan. 14, 1911, Feb 12, 1909); Alice (Oct. 5, 1891); Santa Rosa (Sept. 27, 1891).

Virginia.—Fauquier Co. (Aug. 27, 1901); Short Run, Alexandria Co. (July 29, 1888); Ballston (Aug 14, 1892); Four Mile Run (April 22, 1894; April 13, 1884); Fairfax Co. (May 10, —; Sept. 6, 1879); Smiths Island (May 19, 1898); Brighton (May 18, 1898); Essex Co. (July 15, 1884); Dunn Loring (April 19, 1891; May 3, 1891); Rosslyn (March 5, 1885; July 15, 1876); Arlington (April 30, 1878; Aug. 8, 1889); Gainesville (May 7, 1887); Barnesville (May 17, 1887).

West Virginia.—Charlestown (July 30, 1898).
Tamaulipas.—Alta Mira (April 8, 1898); Matamoras (Feb. 4, 1902).

Troglodytes domesticus baldwini,[7] subsp. nov.

Ohio House Wren

SUBSPECIFIC CHARACTERS. — Similar to *Troglodytes domesticus domesticus*, but upper parts darker, much less rufescent (more sooty or grayish); the sides and flanks less rufescent (more grayish); rest of lower surface more grayish (less buffy).

MEASUREMENTS.—Male: Total length,[8] 111-133 5 mm.; extent of wings,[8] 160-177; wing, 46-52 (average, 49 6); tail, 38-44 5 (41.6); exposed culmen, 10 8 13 2 (11.8); tarsus, 16-18 (17), middle toe without claw, 11 5-13 (12).

Female: Total length,[8] 108-127 mm., extent of wings,[8] 157 175; wing, 46 5-50 (48.7); tail, 38-42 (40.6), exposed culmen, 10 5-12 (11.6); tarsus, 16.5-18 (17); middle toe without claw, 11 5 12 5 (12)

The following additional measurements, taken from birds in the flesh, have been furnished by Dr. S Prentiss Baldwin:

Adult male:[9] Width of bill at base, 3.7-6.4 (average, 4.9), height of bill at base, 3.-4.4 (3 8), width of bill at gape, 6 4-10.5 (7 9); length of head, 18.7-21.7 (19 8), greatest width of head, 13.1-14 8 (14); height of head, 11.1-13 2 (12), length of neck, 18.1-27.8 (23.7); length of sternum, 11 5-14.5 (13); length of body, 23.8-36 (30.3); dorso-ventral diameter of body, 15.1-18 6 (17); breadth of wing, 25.9-42.6 (34 2); length of humerus, 12 7-16 2 (14.4); length of radius-ulna, 14.4-16.8 (15 7), manus, 10.2-14.5 (12.7), femur, 13.4-18 (15.4); tibia, 22.4-25.2 (23 6), inner toe, 5.7-9 2 (7.1), outer toe, 6.2-9.4 (7 3); hind toe, 7.3-9.5 (8.4); claw of hind toe, 4 2-5.8 (5 1); claw of middle toe, 3-4 3 (3.7); length of first (outermost) primary, 15 2-21.8 (18 6); second primary, 28.2-36 (33.2); third primary, 36-41.6 (38.9); fifth primary, 36 7-42.6 (39.8), ninth primary, 42.1-36 7 (39.1); tenth primary, 37-41 (39 1).

Adult female:[10] width of bill at base, 3.5-5.8 (4.7); height of bill at base, 3.2-4.5 (3.8); width of bill at gape, 6.1-10.1 (7.9); length of head, 18.5-20.8 (19 6); greatest width of head, 13.3-14 8 (13.9); height of head, 10.5-13 (11.9); length of neck, 17.5-29.2 (24 3), length of sternum, 8.5-15 8 (12 6); length of body, 26.1-34.3 (30.8); dorso-ventral diameter of body, 11.2-19.8 (16.8); breadth of wing, 27 2-36.6 (33.3), length of humerus, 11.8-16.8 (14.2); length of radius-ulna, 14 16 3 (15.3); manus, 10-13 8 (12.2); femur, 13.1-18 (15.6); tibia, 22-26 (23.5); inner toe, 5.8-8.8 (7.2); outer toe, 5.6-9.2 (7.4); hind toe, 7.1-9.2 (8.4), claw of hind toe, 4.5-6 (5.3); claw of middle toe, 3-4.4 (3 8); length of first (outermost) primary, 16.3-22 7 (18.7); second primary, 30.2-36 (32.5); third primary, 35.3-40.6 (37.5); fifth primary, 35.9-41.3 (38 5); ninth primary, 35.2-40.2 (37.9); tenth primary, 35.5-40.2 (37.4).

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[7] Named for Dr Samuel Prentiss Baldwin, of Cleveland, Ohio
[8] Measured in the flesh by the collector
[9] Thirty-three birds

The weights given below have been sent also by Doctor Baldwin:

Male:[11] Total weight, 8.6–12.2 (average, 10.8) grams; all feathers alone,[12] 0.502–0.620 grams.

Female:[13] Total weight, 9.6–13.7 (11.5) grams, all feathers alone,[12] 0.517–0.730 grams.

TYPE.—Adult male, No. 27823, Cleveland Museum of Natural History; Gates Mills, 15 miles east of Cleveland, in Cuyahoga County, Ohio, July 29, 1932; S. Prentiss Baldwin

GEOGRAPHIC DISTRIBUTION —Central northern United States and adjoining parts of southeastern Canada Breeds north to central southern Quebec, southeastern Ontario, and central Michigan; west to western Michigan, central northern Indiana, and western Ohio, south to central southern Kentucky; and east to central eastern West Virginia, western Pennsylvania, northwestern and northern New York, and central southern Quebec. Winters from eastern South Carolina, southern Georgia, southern Alabama, southern Louisiana, and central Texas, south to central southern Texas and southern Florida. In migration occurs east to Connecticut, Delaware, District of Columbia, and eastern Virginia, and west to Illinois and Arkansas.

REMARKS.—This is the darkest of the forms of *Troglodytes domesticus*. It is always less rufescent than *Troglodytes domesticus domesticus*, but it has not only a dark sooty phase of plumage but also a lighter, more grayish phase that more approaches *Troglodytes domesticus parkmanii*. This latter phase is apparently not to be regarded merely as the manifestation of intergradation, since it appears in all parts of the range of *Troglodytes domesticus baldwini*.

It is a pleasure to dedicate this new subspecies to Dr. S Prentiss Baldwin, whose remarkable investigations of the life history of the house wren of Ohio are well known.

The localities and dates of the specimens of *Troglodytes domesticus baldwini* examined are given below.

Alabama.—Orange Beach (Jan. 23, 1911).

Arkansas.—Delight (Sept. 23, 1911)

Connecticut —New Haven (Oct. 13, 1906)

Delaware.—No further locality (April 23, 1932).

District of Columbia.—Washington (May 5, 1889; Oct. 2, 1889; April 15 and 19, 1891).

Florida.—Wilson (April 7, 1923); Gainesville (Jan. 31, 1887); Istokpoga Lake (March 20, 1923), St Marks (Dec. 31, 1919), Miami (Nov. 28, 1904); Pensacola (Oct. 30, 1927), Blue Spring (Jan. 17, 1882); Palatka (Jan. 27, 1886); Aucilla River (Jan. 20, 1920); Kissimmee (Jan 28, 1901); 5 miles southeast of Everglades City, Collier County (Feb. 12, 1932); Amelia Island (Dec. 26, 1905); Eau Gallie (Jan. 31, 1910); Long Pine Key, Royal Palm State Park (Jan. 15, 1924).

Georgia.—Athens (Sept. 24 and 28, 1930; Oct. 7, 1933); Minis Tract, 2½ miles southwest of Savannah (Nov 5, 1931); Savannah (Feb. 26, 1933); Tifton (Oct. 14, 1931).

[10] Thirty-five birds
[11] Ninety-five birds
[12] Less than ten individuals
[13] Fifty-eight birds

Illinois.—Rock Island Arsenal (May 16, 1892); Olney (May 8, 1917); Cook Co. (April 29, 1878).

Indiana.—Culver (June 18, 1933); Fort Wayne (about 1873).

Louisiana.—New Orleans (Feb. 24, 1898); Marrero, near New Orleans (Nov. 15, 1932).

Michigan.—Putnam (June 23, 1933); Hartland (May 30, 1933); 7 miles south of South Haven, Van Buren Co. (Sept. 19, 1931); Luzerne (Aug. 12, 1914); Waterloo (Oct. 7, 1922); 7 miles southeast of Jackson (June 27, 1933; July 4, 1933); Brown Lake, Dickinson Co. (July 21, 1909; Aug. 9 and 21, 1909); Charity Island (Sept. 9, 1910); Lovells (Aug. 5, 1931); Vermilion (June 25, 1914); Kalamazoo (April 30, 1906); Ann Arbor (May 10, 1922; June 29, 1933; June 30, 1909; Aug. 8, 1926); Steere's Swamp, Ann Arbor (May 18, 1904); Portage Lake, Washtenaw Co. (May 23, 1933); south of Silver Lake, Washtenaw County (July 4, 1933); Connors Creek, Wayne Co. (Sept. 22, 1906); Greenfield Township, Wayne Co. (May 3 and 23, 1905); Greenfield, Wayne Co. (Aug. 18, 1906; May 5, 1907); Monquagon, Wayne Co. (May 28, 1908); Cadillac (May 9, 10, 14, and 15, 1888); Rush Lake, Huron Co. (July 31, 1908); Sandpoint, Huron Co. (June 11, 1933; June 16, 1908; July 1, 3, and 21, 1908), Birchwood Beach, Berrien Co. (April 29, 1918; May 4 and 9, 1918); Warren Dune, Berrien Co. (May 3 and 28, 1926; June 10, 1926); Harbert (July 9, 1919; Aug. 27, 28, and 29, 1917).

New York.—Staten Island (May 10, 1906); Jamaica (Sept. 14, 1898); Mexico (May 20, —), Wawbeek, Franklin Co. (Aug. 7, 1907; Oct. 1, 1907); Mt. Sinai (Sept. 16, 1907).

North Carolina.—Bent Creek, Pisgah National Forest (April 22 and 23, 1930; May 3 and 6, 1930; April 29 and May 1, 1931; April 21, 23, 27, 28, and 30, May 2 and 5, and Sept. 14, 1932; April 20, 1933), Asheville (Oct. 4 and 9, 1930), Beaufort (May 28, 1932); Beaver Lake, near Asheville (April 24, 1930); Montford Hills, near Asheville (April 24, 1930); Mills River (Oct. 8, 1931); Swannanoa (May 3, 1932; Oct. 6, 1933); Pisgah National Forest (Sept. 19 and 29, 1930).

Ohio.—Gates Mills, Cuyahoga Co. (July 15, 16, 19, 22, 27, 28, and 29, 1932; Aug. 1 and 5, 1932; Sept 5, 1932; Sept. 8, 1931; June 7, 1925; June 30, 1926); Cincinnati (July 11 and June 29, 1933); Mayfield, Cuyahoga Co. (June 7, 1933); Solon Bog, Summit Co. (June 29, 1933); North Olmstead (May 5, 1924); 4 miles southwest of Toledo (June 28, 1933); 8 miles west of Toledo (June 25, 1933); 3¾ miles southwest of Toledo (June 23, 1933); Buckeye Lake, Licking Co. (May 11, 1928); New Bremen (May 25, 1917; July 2, 1915; July 19, 1916); Pymatuning Swamp, Ashtabula Co (May 6, 1930; July 22, 1931); Geauga Lake (May 7, 1923).

Pennsylvania.—Calvin (June 7, 1897); Linesville (June 16, 1897); Tionesta (July 7, 1893); Erie (Aug. 1, 1888; Aug. 13, 1877).

South Carolina.—Charleston (Jan. 10, 1891); l'On Swamp, Christchurch Parish (April 22, 1911).

Texas.—Lomita Ranch (Jan. 11, 1881); Sour Lake (March 26, 1905); San Antonio (Jan 15, 1887).

Virginia.—Smiths Island (May 13 and 14, 1910); Dyke, Fairfax Co. (Sept. 21, 1920); Fauquier Co. (April 18, 1902); Four Mile Run (May 1, 1898).

West Virginia.—Petroleum (April 30, 1874); Davis (June 12, 1897).

Ontario.—Red Bay, Bruce Co. (May 29, 1930); Tobermory, Bruce Co. (Aug. 5 and 13, 1930); Long Point, Norfolk Co. (July 21, 1927; June 8, 29 and 30, 1927); Walker's Pond, near London (Oct. 11, 1887); London (May 11, 1883); Beaumans, Muskoka Lake (Aug. 29, 1904); Streetsville (July 28, 1907); Trenton, Hastings Co. (June 5, 1890); Coldstream (May 17, 1914; May 5, 1913; May 9, 1926; May 11, 1927); Eugenia, Grey Co. (Aug. 22, 1894); Sand Banks, Prince Edward Co. (June 25, 1930); Barrie, Little Lake (June 2, 1932); Point Traverse, Prince Edward Co. (June 30, 1930); Sarnia (Aug. 12, 1899); Orillia (May 12, 1888); Killean, Wellington Co (Oct. 3, 1904); Hamilton (May 8, 1885; May 8 and 17, 1890; May 11, 1891); Port Sydney, Muskoka Co. (July 5, 1902; Jan. 25, 1898; Sept. 26, 1907); Pottageville, York Co. (June 29, 1933; June 3, 1926; July 12, 1926; Aug. 3, 1926); Point Pelee, Essex Co. (Sept. 8, 1905; Sept. 16, 17, and 24, 1909; Sept. 19, 1906; Oct. 4, 1909; Feb. 10, 1915), Ottawa (Aug. 4, 1919; Aug. 10, 1922; July 27 and 29, 1933); Moose Creek, Ottawa (Sept. 14, 1929); Toronto (June 4, 1890; Oct. 7, 1907; May 26, 1893); Cedarvale Ravine, Toronto (July 18, 1933; Sept. 27, 1929); Fishermans Island, Toronto (May 7, 1928); Agincourt, Toronto (Sept 23, 1923).

Quebec.—Isle au Canot, Isle aux Grues, near Montmagny (July 19, 1932); Isle aux Grues (Aug. 27, 1929; June 15, 1922).

Troglodytes domesticus parkmanii Audubon

Western House Wren

Troglodytes parkmanii AUDUBON, Ornith Biog, Vol V, 1839 [after May 1], p 310 ("Columbia River"), (type in United States National Museum)

Troglodytes aedon var *aztecus* BAIRD, Review Amer Birds, September, 1864, p. 138, 139 ("Eastern Mexico, from Rio Grande southward") (Type from Jalapa, Vera Cruz, Mexico, in United States National Museum)

Troglodytes aedon marianae SCOTT, The Auk, Vol II, No 4, October 20, 1885, p 351 ("Las Sierras de Santa Catalina, Pima County, Arizona" [in introduction to article]) (type in American Museum of Natural History)

SUBSPECIFIC CHARACTERS.—Similar to *Troglodytes domesticus baldwini*, but much paler, and sometimes more grayish above, sides and flanks paler, rather more rufescent; remainder of lower surface lighter, more buffy.

MEASUREMENTS.—Male. Total length,[14] 117.5–133; extent of wings,[14] 162–177.5; wing, 49 5-53.5 (average, 51 3) mm.; tail, 42–45.5 (44.2); exposed culmen, 11.5-13.5 (12 4), tarsus, 16.5-17.5 (17); middle toe without claw, 11–13 (12 2).

Female: Total length,[14] 104–119; extent of wings,[14] 152–162 5; wing, 49–52.3 (51); tail, 42–47 (44.8); exposed culmen, 11–12 7 (11.7); tarsus, 16–18 (16.8); middle toe without claw, 11–13 (12.1).

Weight of adult: 7 2–12.5 grams.

TYPE LOCALITY.—Lower Columbia River near Fort Vancouver (Vancouver) Washington.

[14]Measured in the flesh by the collector

GEOGRAPHIC DISTRIBUTION.—Central southern and southwestern Canada, central and western United States, and Mexico. Breeds north to central Ontario, southern Manitoba, central Alberta, and central British Columbia; west to southwestern British Columbia, western Washington, western Oregon, and western California; south to northwestern Lower California, southern Arizona, southern New Mexico, central western Texas, central western Tamaulipas, central northern Texas, southern Missouri, southwestern Kentucky, and southern Indiana; and east to southeastern Indiana, eastern Illinois, eastern Wisconsin, northern Michigan and central eastern Ontario. Winters from Arkansas, northeastern Texas, southern Arizona, and central California, south to southern Lower California, Michoacan, Guerrero, Oaxaca, southern Louisiana, and casually to southern Florida.

REMARKS.—This subspecies is even more different from *Troglodytes domesticus domesticus* than from *Troglodytes domesticus baldwini*, since it is so much paler, both above and below, and usually so much more grayish. There are, however, as in *Troglodytes domesticus baldwini*, two color phases, one which represents the extreme of grayness, and another that is much more rufescent brownish above and dull buffy below, sometimes more so than is the gray phase of *Troglodytes domesticus baldwini* Between these two extremes there is a wide range of variation with many kinds of individual intermediates In fact, the most grayish examples look different enough from the most buffy and brownish birds to be of a different species. An occasional specimen of the buff-breasted phase strongly resembles *Troglodytes brunneicollis* but without actually bridging the gap between the two species. In any plumage the present subspecies lacks the very rufescent cast of *Troglodytes domesticus domesticus*

Birds from Brookville and Connersville in southeastern Indiana verge toward *Troglodytes domesticus baldwini*, but are nearer the present form. Those from northern Michigan as far south as Cheboygan County are likewise more or less intermediate but apparently belong here. The considerable series that we have seen from central eastern Ontario indicates that *Troglodytes domesticus parkmanii* ranges east in that region as far as Lake Abitibi and the Algoma District.

Rather surprisingly the house wrens from the Mississippi Valley do not seem to be separable from those of British Columbia and other parts of the Pacific coast region, nor from the birds that breed in Arizona. A re-examination of all our present material thus confirms Robert Ridgway's conclusions regarding this matter.

The localities of the specimens of this race that we have examined are listed below.

Arizona.—Chiricahua Mts. (Sept. 4, 10, and 16, 1932); Fairbank (May 20, 1893); Fort Whipple (May 15, 1865, Sept. 15, 1914); Graham Mts. (May 20 and 22, 1914); Huachuca Mts. (May 19, July 23, 27, and 30, 1932; Aug. 4 and Sept. 29, 1929); Lakeside (July 5, 1915); Lakachukai Mts. (June 19, 1927); Mt. Turnbull (June 10, 1916); Quitovaquito (Jan. 30, 1894), Santa Rita Mts. (July 5, 1884); Topock (Sept. 27, 1917).

California.—Laguna, San Diego Co. (June 21, 1894); Los Angeles (Jan. 16, 1891); Mona Lake (Sept 16, 1901); New Richmond (Jan. 21, 1923); Panamint Mts (April 11, 1891); San Bernardino (Dec. 28, 1890); San Jacinto Mts. (Aug. 2, 1905); Sierra Nevada Mts (Aug. 21, 1891); South Yollo Bolly Mt. (July 28, 1905).

Florida.—One and one-half miles west of Everglades City (Feb. 11, 1932).

Idaho.—Albion (Aug. 3, 1910); Blackfoot (July 14, 1890); Edna (June 22, 1910); Florida Mt., Owyhee Co (June 1, 1932); Malad (July 19, 1911); Shelley (July 30, 1911).

Illinois.—Champaign (April 29, 1933); Hamilton (April 29, 1909); Peoria (no date); Richland Co. (May 25 and 29, 1883; June 2 and 6, 1890), Warsaw (May 6, 1909)

Indiana.—Brookville (April 30, 1887); Connersville (no date); Wheatland (April 20, 1883; May 2, 1885)

Iowa.—Fairfield (May 17, 1890), National, 14 miles west of McGregor (no date).

Louisiana.—Bienville (April 18, 1932).

Michigan.—Bruce Crossing, Ontonagon Co. (Aug. 24, 1931); Burt Lake, Cheboygan Co. (July 6, 1932), 12 miles northeast of Ironwood (July 11, 15, 17, 23, 25 and 26, 1932); McCargo Cove, Isle Royale (May 29, 1930); Montreal River, Gogebic Co (Aug. 26, 1931), Porcupine Mts., Ontonagon Co. (July 24 and 25, 1904)

Minnesota.—Carlton Co (July 9, —); Fort Snelling (May 15, 1890; May 9, 16 and 27, 1891; June 3, 1903); Minneapolis (no date).

Mississippi.—Bay St Louis (Oct 8, 1898).

Missouri.—Willow Springs (Oct 4, 1892)

Montana.—Thompson Falls (July 26, 1895).

New Mexico.—Magdalena Mts. (Aug. 30, 1909); Riley (Sept. 22, 1905); Rio Puesco (Sept. 6, 1905).

North Dakota—Larimore (June 28, 1915); Sweetwater (May 17, 1902).

Oregon.—Portland (June 23, 1897).

South Carolina.—Port Royal (Jan. 29, 1891).

Texas.—Atascosa County (April 24, 1933); Cameron County (April 20, 1890), Corpus Christi (Jan. 22, 1887); Guadalupe Mts. (Aug. 21, 1901); Hempstead (no date), Kerrville (May 2, 1889); Nueces Bay (Dec. 1, 1891); 10 miles east of Pleasanton (Jan. 8, 1933); Rice, Navarro Co. (Sept. —, 1880); San Antonio (April 11, 1889; April 15, 17, and 18, 1890; Feb. 5 and 6, 1890).

Washington.—Port Angeles (July 23, 1921); Vancouver (June —, 1835).

Wisconsin.—Bridgeport (May 27 and 29, 1912); Danbury (May 27, 1919); Mather (May 25, 1918); Mamekagon Lake (May 31, 1919); Orienta (June 14, 1919); Mellen (June 10, 1919); Outer Island (July 9, 1919); Potosi (June 5 and 6, 1912); Rib Hill (July 3 and 9, 1918), Solon Springs (Aug. 1, 1919).

Alberta.—Eight miles northwest of Red Deer (July 13, 1896).

British Columbia.—Comox (June 1, 1895); Cranbrook (May 10, 1914); Lund (July 16, 1897).

Manitoba.—Gypsumville (May 26 and 28, 1931; June 8, 1931).

Ontario.—Echo Bay, Algoma Dist. (July 15, 1931); Laird (June 9, and 15, 1931); Big Fork, Rainy River (July 16, 1929; Aug. 3, 1929); Emo, Rainy River (June 8, 12, 17, 20, and 27, 1929); Clearwater, Rainy River (July 5 and 8, 1929); Lake Abitibi (July 7, 8, and 10, 1925); MacLennan (July 4, 6, 7, and 22, 1931); Weatherbee, Lake Nipigon (June 27, 1924).

Chihuahua.—Batopilas (Oct. 4 and 5, 1898).

Hidalgo.—Tula (Mar. 9, 1893).

Michoacan.—Zamora (Jan. 24, 1903).

Nuevo Leon.—Monterey (Feb. 7, 1891).

Puebla.—Metlaltoyuca (Jan. 19 and Feb. 19, 1898); Tehuacan (May 4, 1893).

Sonora.—Alamos (Jan. 4, 1899).

Tamaulipas.—Alta Mira (April 12, 1898); Camargo (Jan. 9, 1902).

Vera Cruz.—Orizaba (no date).

Physical Science.

The purpose of this book has been set forth in the preface by the authors, stating that it "is intended for an orientation course in Physical Science." It contains some twenty chapters devoted to the subjects astronomy, geology, meteorology, chemistry, classical physics and modern physics. In addition there are four appendices of units, atomic weights and physical constants. In short, it is a new book on general science As a book introducing general science it is, of course, written in a most elementary fashion, describing quite accurately, however, many of the phenomena which one observes in nature, as accurately perhaps as one can describe such things without enlisting the aid of elementary arithmetic or algebra It is printed on good glossy paper, bound durably in cloth, and has the appealing feature of many clear and descriptive diagrams.

When the reviewer was a freshman in high school a text similar to this was used in general science. It seems deplorable that our institutions of secondary education have degenerated to levels that demand the use of such a book in our colleges and universities.

HAROLD H NIELSEN

College Physical Science, by McCorckle and Lewis. ix+327 pp Philadelphia, P. Blakiston's Son & Co., 1934. $2.00.

The Preparation of Scientific Papers.

This book is a splendid guide to the efficient writing, revising and illustrating of articles for publication in scientific journals The right and wrong methods of presenting subject matter, tabular material, bibliographies and illustrations are all carefully described and illustrated. Much time, trouble and disappointment would be saved if all authors would carefully read and follow the excellent suggestions given here. The book should be in every scientific library and on the personal shelf of every author —L. H S.

The Wistar Institute Style Brief. 169 pp., paper covers. Philadelphia, The Wistar Institute Press, 1934.

ECOLOGICAL STUDIES OF *ARGIA MOESTA* HAGEN (ODONATA: COENAGRIONIDAE) BY MEANS OF MARKING.

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INTRODUCTION.

These studies were carried on during the summers of 1931 and 1932 along the Olentangy River about three miles north of Worthington, Ohio, and on the western portion of the Brown Fruit Farm, which borders the east side of the river at this point. It was noted at the outset that the different sexes and color forms of *A moesta* seemed to occur in different proportions in different parts of the area studied; and the appearance of distinct color forms gave the impression that this species might be polychromatic, as a few species of dragonflies seem to be, or the color forms might be merely an indication of the age of the adult, as is the case with most of the color variations in adult dragonflies. In order to throw some light on the activities of this species, its distribution over the area, and the nature of its variation in color, considerable collecting was done along the river and on the western portion of the fruit farm A system of marking was devised so that individual specimens could be recognized if recaptured and hence data concerning their movements and activities could be obtained.

Argia moesta Hagen.

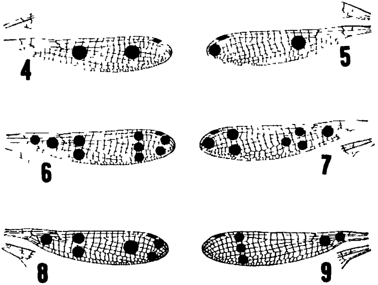
According to Williamson (6)[1] there are five geographic variations in the color pattern of the males of this species. The form with which this paper deals is that described as Type II by Williamson, or as *putrida* by Hagen (5). Detailed descriptions of this form are given by Byers (1, 2), Garman (4), Hagen (5), and Williamson (6).

The adults in any given locality show distinct variations in general color. The color pattern of the thorax and abdomen consists of two colors, black and a lighter color The black, except possibly in the male, comprises only a small portion of the body surface, and the general color of the insect is due to

[1]Numbers in parentheses refer to the bibliography at the end of the paper

MARKING.

Most of the experiments in marking insects mentioned in entomological literature have consisted of marking lots of insects and releasing them at some central point to determine their range of dispersion. The marking was usually done by applying some sort of stain, ink, paint, or enamel to the insect with an atomizer or spray gun. In only a few cases, notably the experiments with bees by Von Frisch (3), have insects been marked so that individual specimens could be recognized if recaptured; in such cases the marking was usually done with



Figs 4 to 9 Figures illustrating the method of marking.

Fig 4 No RH0110 Fig 5. No LH0101.
Fig 6 No RF2232 Fig. 7. No LF1321.
Fig. 8 No RF1212. Fig. 9. No. LF2030.

a small brush or stick. As far as the writer is aware, no marking experiments of any sort have been carried out on dragonflies.

In this study, specimens of *Argia moesta* were marked on the ventral surface of the wings with dots of india ink, a different combination of dots being put on each insect. The ink was applied with a small pointed stick. The dots were placed at one or more of four different positions on the wing, and the number of dots placed in each of these four positions made a four-figure number which was the identification number of

the insect marked (see Figs. 4 to 9, inc.). By this method a great many different combinations can be devised, and records can be kept of a large number of individual specimens.

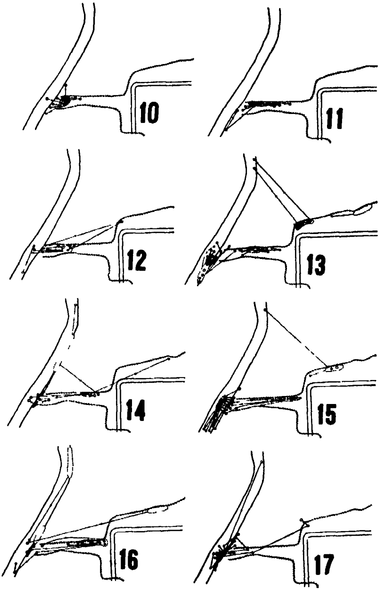
Little difficulty was experienced in applying the ink to the wings, and the insects were in no way injured by the treatment. The marking was done in the field where the insects were captured, and the insects were released immediately after marking. This method worked very satisfactorily, and individuals recaptured as long as 24 days after being marked still retained the marks on their wings distinct enough to be read. In cases of returns where the marks were partly rubbed off so that there was a question as to the identity of the specimen (such cases were relatively few), the record was discarded.

DATA.

Marking Data—During the two seasons a total of 830 specimens of *A. moesta*[2] were marked, of which 178 (21.5%) were recaptured Many of these were recaptured more than once; thus a total of 227 recaptures was obtained. These returns have brought out some interesting facts concerning the movements, color change, and length of adult life of this species.

Movements.—The movements of this species, as indicated by the recaptures of individuals marked at 18 of the 25 stations, are shown graphically by the maps in Figs. 10 to 17, inclusive There is quite a bit of movement upstream and downstream for short distances, but only a few cases of individuals flying for any great distance up- or downstream There is considerable movement of individuals to and from the river, chiefly via the air drains. A large proportion of the recaptures (93 out of the 227) was obtained in the same station in which the specimens were marked, indicating that many individuals remain in one locality for a considerable length of time. Movement from one station to another is apparently rather slow. Of the specimens taken along the edge of the woods and orchard (stations 22 to 25), some seem to have come from the river via the air drain, while others may have come through the woods from further upstream (see Figs. 13 and 15)

[2]During these two seasons 77 specimens representing 9 other species of Odonata were also marked These species, with the number of individuals of each marked, are as follows *Argia sedula* Hagen, 32, *Hetaerina americana* Fab , 27, *Argia apicalis* Hagen, 7; *Ischnura verticalis* Say, 3, *Enallagma exsulans* Hagen, 2; *Plathemis lydia* Drury, 2, *Sympetrum vicinum* Hagen, 2, *Argia violacea* Hagen, 1, *Libellula luctuosa* Burm , 1. Only six returns from these were obtained, four being *H americana* and two *A sedula* The returns were obtained after from two to seven days; they indicated very little movement, and no color change.



FIGS. 10 TO 17. Maps Showing Movements of Individuals.

These maps represent the central portion of the area shown in Fig. 8; the scale is the same. Each map shows the recaptures obtained from individuals marked at one or more stations. The stations where the individuals were marked are indicated by broken lines; the small circles indicate points of recapture; the lines connecting the circles to the marking station show the direction of movement. Circles within the marking station indicate recaptures in the station where the

Color Change.—The data concerning color change may be summarized as follows:

	Records	Maximum No. of Days
REMAINING THE SAME COLOR:		
Brown (males and females)	22	6
Blue (males and females)	71	24
Pruinose (males)	39	24
Dark (females)	3	4

	Records	Days Elapsing
CHANGING COLOR:		
Brown to blue (males and females)	24	2 to 19
Brown to dark (females)	3	13 to 16
Brown to pruinose (male)	1	18
Blue to dark (females)	15	2 to 15
Blue to pruinose (males)	2	4 to 5
Dark to blue (females)	11	2 to 9
Blue to dark, then black to blue (females)	2	2 and 4 to 15 and 19

Color in the males seems to be directly correlated with age, the brown individuals being the youngest and the pruinose ones the oldest. In the females the brown individuals are the youngest, and the blue and dark individuals the oldest; since they may change from brown to blue in two days and from brown to dark in apparently not less than 13 days, it would seem that the brown individuals turn blue first and later turn dark. Since dark individuals may turn blue again, it appears that the dark condition is, in most cases at least, only temporary. The fact that practically all the dark females were taken along the riffles in tandem with males suggests that possibly the dark color is brought about by certain internal phenomena correlated with sexual maturity.

Length of Adult Life.—This can be deduced from the data given in the table above. Although some individuals remained brown for 6 days, most of the recaptures of brown individuals

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individuals were marked. In some cases, recaptures of individuals marked at two or more stations are shown on the same map. Due to the limitations of space, not all the recaptures obtained are shown, but those shown are typical.

Fig. 10. Recaptures of individuals marked at station 15.
Fig. 11. Recaptures of individuals marked at station 16
Fig. 12. Recaptures of individuals marked at station 17
Fig. 13 Recaptures of individuals marked at stations 4, 18, 22, and 25.
Fig. 14. Recaptures of individuals marked at stations 9, 14, and 19
Fig. 15. Recaptures of individuals marked at stations 6, 20, and 23
Fig. 16. Recaptures of individuals marked at stations 8, 10, 21, and 24.
Fig. 17. Recaptures of individuals marked at station 7.

were obtained after only 1, 2, or 3 days Most of the recaptures of blue (female) and pruinose (male) individuals were obtained after periods considerably shorter than 24 days. The maximum length of adult life is about four weeks, the average probably being about three weeks.

Population Data.—During the seasons of 1931 and 1932 a total of 1,542 records of *A. moesta* were obtained, as compared with 402 records of 24 other species of Odonata[3] Of the 1,542 records, 545 were obtained along the river, 789 in the air

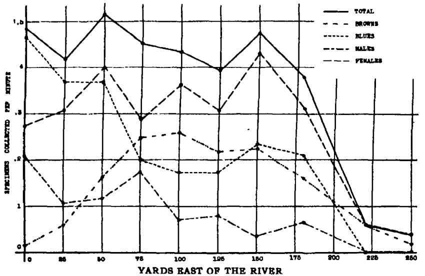

FIG 1. Graph showing the relative abundance of sexes and color forms along and east of the river (1932).

drains, 54 in the woods, and 154 along the edge of the woods and orchard. No specimens were taken east of station 25. The analysis of these records has brought out certain facts regarding the sex ratio, distribution of sexes and color forms, and daily abundance of this species.

Sex Ratio.—During both seasons the females were more abundant than the males. In 1931 the ratio was 31.41% males and 68 59% females; in 1932 it was 32.73% males and 67.27% females. There are thus more than twice as many females as males.

[3]The Odonata of the Brown Fruit Farm, as observed by the writer during these two seasons, are discussed in a paper to be published in the near future in a bulletin of the Ohio Biological Survey.

Distribution of Sexes and Color Forms.—The relative abundance of the different sexes and color forms along the river and at different distances east of it in the north air drain and orchard is shown graphically in Fig. 1 In this graph relative abundance has been indicated in terms of specimens collected per minute. The increased abundance of the blue (older) individuals along the river is undoubtedly due to the fact that mating and oviposition, activities of only the older individuals, take place there. The increased abundance of individuals at 150 yards

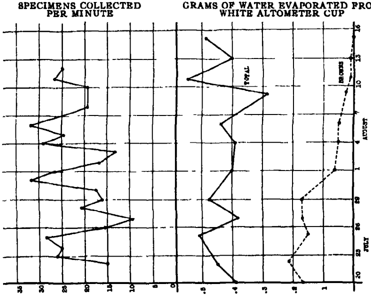

FIG 2 Graph showing the relative daily abundance and evaporation data (1932)

from the river (the end of the air drain and the beginning of the orchard) is probably due to the fact that some of the individuals taken there (stations 21 and 22, particularly 22) came from the river by way of the air drain, while others came through the woods from further upstream.

Daily Abundance.—The relative abundance of all adults, the relative abundance of brown adults, and the evaporation data, for the season of 1932, are shown graphically in Fig. 2. It is interesting to note that the relative abundance of brown individuals, and consequently the rate of emergence of adults, decreased during the period of observation. Another interesting

point, which the graph does not show, is that the abundance of individuals in the air drain and orchard fell considerably near the end of the period of observation. During August most of the collecting was done along the river, where the individuals were most abundant; hence the relative abundance of all adults does not decrease with the decrease in rate of emergence.

During the two seasons various meteorological data were obtained, but none showed much correlation with dragonfly abundance except evaporation data. It will be noted from the graph that in general, periods of high evaporation are characterized by increased abundance. However, this increase is probably only apparent, due to the increased activity of the insects during these periods.

An attempt was made, using the information obtained from marking and collecting data, to calculate the actual daily population of *A. moesta* on the area. The calculations were based on the relative number of marked individuals recaptured on successive days, with allowances made for shifts in population due to movements in and out of the area and to death and emergence. Such calculations indicate that the daily population is probably several hundred.

Only a small fraction (never more than 100) of the total population was ever taken on any one day. This may have been due to the way in which the collecting was done, viz., time was taken to mark practically all individuals taken; or to the fact that the entire area was not worked each day; or many individuals may simply have been overlooked, due to their habit of remaining for long periods perched on some exposed leaf.

DISCUSSION.

Since no brown individuals except some very teneral ones were taken along the river, it would seem that within a few hours after emergence, as soon as the body hardens sufficiently, the adults fly away from the river, up into the woods or air drains. There they remain for several days, feeding and moving from place to place rather slowly. In some cases they do not seem to move more than 25 yards in two or three days. General movement, as from one station to another, is not to be confused with rate of flight. Individuals of *A. moesta* may fly quite rapidly at times, but the results of this study indicate that they do not fly rapidly for any great distance, but remain for a considerable time in the same locality (station). By the time

the adults are a week or ten days old, they move about a little more rapidly. They may return to the river for a time, and then fly back into the air drains. Females fly up into the air drains to a greater extent than males.

When the adults are about 14 days old they return to the river and mate. This species is rather promiscuous in its mating; a single female may mate with several different males, or a single male with several females. Only the older individuals mate. The males by this time are almost or entirely pruinose; the females are only pruinose ventrally, and are dark laterally and dorsally. After mating, the pruinose males remain white, but the dark females may become blue again. The older blue females thus seem to be individuals which have ceased laying eggs. These older blue females, often with muddy abdomens and wings, may fly back into the air drains again; the males after mating may fly to the top of the high bank, but never go as far from the river as do the older females. The adults of both sexes may live a week or more after the first mating.

Most of the movement that occurs is to and from the river via the air drains; there is relatively little movement upstream or downstream. During wet and cool weather the adults are more or less inactive, and spend most of the time perched on vegetation near the river. During high water, when the water willow is flooded, the older adults are forced up into the air drains.

The peak of abundance for this species is during the latter part of July. By the middle of August there are no more brown individuals present, indicating that emergence has ceased. Although no collections were made after August 15, it is quite likely that by the middle of September all the adults would have disappeared from the area.

SUMMARY.

These studies were carried out along the Olentangy River about three miles north of Worthington, Ohio, during the summers of 1931 and 1932. Collections were made of *A. moesta* in different parts of the area, and a system of marking was devised so that individual specimens could be marked and their activities studied. The method of marking consisted of applying different combinations of dots of india ink to the wings by means of a small pointed stick. During the two

seasons 830 individuals were marked, of which 178 (21.5%) were recaptured, from 1 to 24 days after being marked. From the recaptures of these marked individuals, and from collecting data, numerous facts were disclosed concerning the activities of this species.

The adults do not fly very far, and their movement from place to place is rather slow Most of the movement is to and from the river; there is relatively little movement upstream or downstream. The adults undergo a definite color change during their life; they are brown for a few days after emergence, then they become blue and later pruinose; the males become entirely pruinose and appear whitish, while the females are only pruinose ventrally; at the time of mating the females become dark dorsally and ventrally, but may turn blue again later. The adults live three or four weeks after emergence.

The ratio of males to females is about 1 : 2; the two sexes occur in almost equal proportions along the river, but away from the river the females are much more abundant. Brown individuals are scarce along the river and at a considerable distance from it, but are fairly abundant about 100 yards from the river. Blue (older) individuals are most abundant along the river. During the season, periods of high evaporation seem to be accompanied by increased abundance. Calculations based on marking and collecting data indicate that the daily population of this species on the area studied is probably several hundred, although less than 100 were collected any one day. This species is distinctly a sun-loving insect, but shows no pronounced distaste for vegetation.

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SOME ANCIENT COSMOGONIES AND EVOLUTION.

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Far too often the academician, like the layman, classes the rich mythology of the ancients with the modern animal stories and the fairy tales of children. Thus he dismisses the strifes, woes and victories of ancient deities as being outlandish tales of anthropomorphic gods whom no one, in these days of enlightenment, propitiates or entreats, and whose memory would be buried in eternal oblivion were it not for musty books and inquiring scholars Why consider ancient mythology? Is not much of it fragmentary, and even that which we have often inconsistent? Have not numerous myths been vitiated and frequently modernized with each copying? All this, we admit, is very true. We are often perplexed! However, there is one error in the above view; there is one thought which the critic has not grasped. A myth is more than a tale that is told, for in it, with its poetic language and personified and deified forces of nature, rests the thought—the profound thought—of the ancients. These legends are not the epics of an individual, but the poetry and philosophy of a race.

We point with pride to the progress we have made in our control over nature—to the speed with which we travel, the ease with which we communicate with those at a great distance and the quality and quantity of the goods which we are able to produce. And yet, we forget the momentous discovery which primitive man made when he discovered the principle of the wheel—the cog which plays so large a part in our mechanized civilization. Truly this principle—the idea of a primitive man—is more fundamental to civilized life today than it ever has been. Have we improved much upon the principle of the wheel, or have we merely applied it?

Just as we have noted the importance of a primitive (but momentous) discovery for our present-day civilization. so also may we find in the realm of thought certain ideas which have been held through the ages as more or less fundamental. This is most certainly true with regard to ideas of origin and development, as numerous writers, including the present writer,[1] have

[1]Dudycha, G J "What Is Evolution?" *Scientific Monthly*, 29 317-332, October, 1929

pointed out. Unfortunately, however, we have too long neglected the more ancient ideas of origin and have begun with the Greeks, as though they were the first to speculate concerning the profound problem of how-did-things-come-to-be-what-they-are. In the case of the ancient Egyptians and Babylonians we found, when we divested their ancient legends and myths of their theological implications and deity names, that they held as fundamental certain ideas which were strikingly like, and which antedated, those of the Greeks.[2] In the present article, we shall try to search out diligently the ideas of origin as found among the ancient Indians and Iranians, and see if their ideas bear any likeness to the ideas of the Greeks or to more modern ideas of development and evolution with which we are familiar.

When we turn to the ancient sources of the Indian and Iranian ideas of origin we encounter some difficulties. We can not ascribe the various books and hymns to particular writers, as we can in the case of the Greeks. Nor can we ascribe a definite date to these writings.

To discover the ancient Indian ideas of origin, we turn to the ancient or Vedic period of their literature. To this period belong the four Vedas of which the most ancient, the ***Rigveda***, is the most important. *Rigveda*, which may be translated as Verse-Wisdom, is sometimes characterized as the "book of psalms," for it consists chiefly of lyrics in praise of the various gods. This ancient collection of Verse-Wisdom of India consists of a little over one thousand hymns which are grouped in ten books of varying length. The tenth book, which contains the material in which we are primarily interested, appears quite definitely to have been written at a later date than that of the writing of the first nine. Since the whole of this collection of Verse-Wisdom was not written at one time but over a longer or shorter period, a particular date can not be ascribed to the composition of the hymns. Nor is it easy to place these hymns roughly for they were perpetuated orally through numerous generations. Scholars who have studied the literature of the Vedic period most carefully are not in complete agreement as to the approximate date of the composition of the hymns of the *Rigveda*. Hopkins in discussing the approximate date of the composition of the Verse-Wisdom of India says: "One

[2]Dudycha, G. J. "Ideas of Origin Among the Ancient Egyptians and Babylonians," *Scientific Monthly*, 32. 263–269, March, 1931.

thousand B. C. is, then, not the lowest, but the highest limit that we can reasonably set to the Rig Veda, and 800 B. C. is probably nearer the mark, as far as the bulk of the Rig Veda is concerned."[3] Another scholar, Macdonell, agrees with Hopkins.

Professor Das, however, another authority who has studied the subject very carefully, presents a different theory as to the period to which the *Rigveda* belongs. He has gone to the hymns themselves and has compared various statements found there, with astronomical, geological and cultural facts which have been calculated to belong to a very early period of cultural history. On the basis of his studies, he concludes: "Taking the lower estimate as correct, it would not be unreasonable to guess that some of the Rigvedic hymns were as old as 25,000 years."[4] The arguments which Das gives in support of his theory seem sound and quite convincing. If he is correct in his interpretations and comparisons, then the ideas of origin found in the sacred literature of ancient India antedate those of the Greeks and even those of the ancient Egyptians and Babylonians by many millenia.[5] Let us turn to these primeval ideas and discover how the ancient Indians viewed the problem of how-did-things-come-to-be-what-they-are.

First we shall consider the more mythological notions, and later those which are more definitely philosophical. According to ancient Vedic ideas, the world was divided into three parts—earth, atmosphere and sky or heaven—each of which was represented by a god. When the universe is referred to, however, Dyavaprthivi ("Sky and Earth") is the name which is used. Sometimes one god, and at other times all the gods are said to have created heaven and earth and all things And again, heaven and earth are said to be the parents of the gods. This paradox, that the gods created heaven and earth which are their parents, apparently was not confusing to the ancients, but merely enhanced for them the mystery of creation. This paradox is not merely peculiar to the earlier mythological notions, but is also found incorporated in the later philosophical ideas. This self-contradiction they avoided in part, however, by declaring *Aditi* as the mother of the gods—the Primordial

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[3]Hopkins, E. W "India Old and New," p 30, New York, 1901
[4]Das, A. C. "Rigvedic Culture," p. 35, Calcutta and Madras, 1925
[5]See Dudycha, G J, *ibid*

Force of Nature. Thus we read in the seventy-second hymn of the tenth book of the *Rigveda:*

THE HYMN TO BRAHMANASPATI, X, 72.

The genesis of the bright gods
We will declare with wonder deep,
Uttered in hymns for him who shall
In coming generations hear.

Brahmanaspati like a smith
Together forged whatever is;
When gods existed not as yet,
Then being from non-being rose.

In times when gods existed not,
Then being from non-being rose,
The spaces of the world were born,
From her they call Uttanapad.

The earth was from Uttanapad
Born, and the spaces from the earth;
From Aditi arose Daksha,
Again from Daksha Aditi.

Born first of all is Aditi,
Who, Daksha, thine own daughter is;
After her were the gods produced,
The blessed and immortal ones.

When ye stood in the swelling flood,
Ye gods, who well established are;
Then as from dancers from you whirled
Upward in mighty clouds the dust.

When ye like mighty athletes caused
The worlds, ye gods, to emanate,
Then lifted ye the sun on high,
That in the ocean hidden lay.

Eight valiant sons had Aditi,
Who from her body were produced.
With seven she went among the gods,
While she the egg-born cast away.

With seven sons went Aditi
Up to the ancient race divine;
The egg-born she surrendered to
The sway of birth and now of death.[6]

[6]Taken from Griswold, H. DeW., "Brahman: A Study in the History of Indian Philosophy," pp. 27-28, New York, 1900.

Here we find a number of significant ideas expressed. In the second stanza, we find the idea of design in the universe, for we are told that even before the gods existed "Brahmanaspati like a smith together forged whatever is." Before the gods existed, who preceded the rest of creation, all creation was determined. Also we note that non-being and being are not held as in opposition to each other, but the former is considered as the source or root of the latter—from non-being comes being. And in this process we have a process of becoming for the "spaces of the world" were born. This process of becoming is suggested elsewhere, as we shall see. In the fourth stanza we have a paradox—"from Aditi arose Daksha, again from Daksha Aditi"—but in the fifth it is brushed aside by definitely stating that Aditi was "born first of all." Aditi means "Unbinding" or "Boundlessness." This is especially significant for it immediately suggests to us Anaximander's idea of "the boundless" as the source of all things. Again we find this same idea among the Egyptians, for Neb-er-tcher was believed to be an almighty and invisible power which filled all space—an indefinable, boundless something from which all things issue. Thus Aditi comes to be merely the Indian label for an idea which we find in the thought of various peoples of different ages and different lands.

In the sixth and seventh stanzas, we find two significant ideas expressed. First, the idea of the primacy of water, "the swelling flood," which was before the gods were established and from which they came. This idea, a most common idea, we have encountered elsewhere It suggests Nu, the watery abyss of the Egyptians, and the ancient Sumerian myth which holds, "Then we created the gods in the midst of their waters." It suggests Thales, the Ionian, Aristole, the Peripatetic, as well as the modern biologist Whether 3,000 or 25,000 years old, this is truly an ancient idea A second idea which we find here is that of activity—a creative force. "Then as from dancers from you whirled upward in mighty clouds of dust," the things created, and even the sun which "in the ocean hidden lay" was lifted up on high. There was activity, a creative force, in the primal mass from which all things have their being. Is this a new idea to us? We can hardly say that it is. The reference to Aditi as the egg-born, found in the last stanza, we shall refer to later.

In another hymn, Rigveda X, 82, we find the idea that the

whole of creation evolves out of the creator himself—first the gods and then all animate and inanimate things which are produced by the creative force with the assistance of the gods. Besides the idea of the primal watery mass, which existed even before the creator was born, which we have noted in other Vedic hymns, we have here another idea which we shall observe again in another connection, namely, that of the "embryo in which all the gods were aggregated." In the beginning, in the primitive embryo were all the gods contained in potential form and hence the whole of creation. Hence things come to be what they are by some process of unfolding, of making manifest that which was potential, and all according to some design which we forged "when gods existed not." This idea may rightfully be labeled "evolution." In another hymn (Rigveda X, 121) we encounter essentially the same idea. Here is described a "Golden Germ" as creator of heaven and earth, of the waters and all that lives

What time the mighty waters came, containing the universal germ, producing Agni,
Thence sprang the gods' one spirit into being. What god shall we adore with our oblation?
He in his might surveyed the floods, containing productive force and generating Worship.
He is the god of gods, and none beside him. What god shall we adore with our oblation?
Ne'er may he harm us who is earth's begetter, nor he whose laws are sure, the heaven's creator,
He who brought forth the great and lucid waters. What god shall we adore with our oblation?[7]

In the preceding Vedic hymns which we have considered, we noted that the ideas of origin are set forth, by and large, in terms of the gods and sacrifices—mythology. In the last hymn which we shall consider, Rigveda X, 129, the famous philosophical hymn—the Hymn of Creation—we shall note that mythology has passed into philosophical speculation. This famous hymn, which contains some passages that are still difficult to render, embraces the essential mythological notions which we have been considering, but sets them forth in a more abstract and philosophical manner. Macdonell presents the following rendering:

[7]Gray (Editor), "The Mythology of All Races," Vol VI, Keith, "Indian," p. 51, Boston, 1917

HYMN OF CREATION, X, 129

Non-being then existed not nor being:
There was no air, nor sky that is beyond it
What was concealed? Wherein? In whose protection?
And was there deep unfathomable water?

Death then existed not nor life immortal;
Of neither night nor day was any token.
By its inherent force the One breathed windless:
No other thing than that beyond existed

Darkness there was at first by darkness hidden;
Without distinctive marks, this all was water.
That which, becoming, by the void was covered,
That One by force of heat came into being

Desire entered the One in the beginning,
It was the earliest seed, of thought the product
The sages searching in their hearts with wisdome,
Found out the bond of being in non-being

Their ray extended light across the darkness:
But was the One above or was it under?
Creative force was there, and fertile power:
Below was energy, above was impulse.

Who knows for certain? Who shall here declare it?
Whence was it born, and whence came this creation?
The gods were born after this world's creation:
Then who can know from whence it has arisen?

None knoweth whence creation has arisen,
And whether he has or has not produced it:
He who surveys it in the highest heaven,
He only knows, or haply he may know not[*]

This hymn, unlike some that we have considered, does not begin with a god nor even a creator, but begins by emphasizing the idea that before creation began nothing existed, not even non-being—"non-being then existed not nor being"—save "That One" who "breathed breathless then in self-existence" and "other than it of any kind, there was not." Let us note well that this source-of-all-things, in this hymn, is not labeled as a god, but is merely referred to as the "One" or "That One"—the "It" which has no beginning The source of creation, according to this Vedic hymn, is impersonal As we read on, we find that all was darkness, and by darkness covered; all was in a watery chaos. In this void, however, something

[*]Macdonell, A A. "Hymns from the Rigveda," pp 19 20

was becoming; That One by his own generative force came into being—the potential became actual. Another rendering of these lines is: "A germ lay hidden in its secret casing, which by the might of heat was born as That One." Here again we find the same cosmogonic notion which we encountered as "embryo" in Rigveda X, 82, and as the "Golden Germ" in Rigveda X, 121. Is it not significant that these ancient Indians held this notion of the potentiality of all things in a primordial seed or germ from which all things come by a process of becoming? Also let us remember that this notion is not peculiar to Vedic cosmogony; we have encountered this idea before. The ancient Egyptians believed that in Nu, the great watery abyss, all things were in a "state of helpless inertness" from which they were freed by becoming actual. For Augustine, also, all things were potential in an original germ or seed from which all things come. It is this potentiality of forms in the primordial mass which seems to be common to all of these concepts.

In the beginning the One had desire, the product of thought, which was the first seed and the bond of non-being and being. Thus ideas preceded creation and brought being from non-being. Also "creative force was there, and fertile power" which worked itself out into the actual. The hymn ends emphasizing the unity of the creative force, but also with the question: Who knows for certain whence came this creation?

Now that we have an idea of the ancient Vedic ideas of Origin, let us turn to the ancient Iranians and survey their cosmogonic ideas.

For a knowledge of the ancient Iranian ideas of origin, we turn to the *Zend-Avesta*, the sacred books of the Parsis, which is really a collection of fragments of varying antiquity. Of these sacred books, the first part, often called the Avesta proper, contains the Vendidad, which is a compilation of religious lore and mythological tales; the Visparad, which is a collection of litanies for the sacrifice, and the Yasna which is a collection of litanies and also includes the five hymns or Gathas. Just as we have found, when we considered the Indian Vedas, that scholars are not agreed as to the date of the Vedic hymns, so also in the case of the *Zend-Avesta*, scholars differ as to what dates are to be ascribed to the sacred books of Parsis.

Dr. Haug assigns a not much later date than 1200 B. C. to the Gathas, and fixes that of the much larger part of the

Vendidad at 900 or 1000 B. C. Pike, however, thinks "that the Gathas are much older, even, than that, and perhaps older than the Rig Veda." He says:

Cauis Plinius the Second, tells us, in the Thirtieth Book of his Natural History, that Eudoxus said that Zarathustra lived 6,000 years before Plato (who was born 429 years before Christ), and that so it is asserted also by Aristoteles. Hermippus, Pliny informs us, who made a diligent study of the works of Zarathustra, explaining an immense number of verses, stated that he lived 5,000 years before the Trojan War (which is supposed to have taken place about 1,190 years before Christ).[9]

In the *Sacred Books and Early Literatures of the East*, however, the date for the Gathas is placed about 2000 to 600 B C., and that for the Vendidad at 600 to 400 B C. If Pike is right, then the *Zend-Avesta* is a source of ancient ideas which date back to around 6000 B. C., and thus are around 8000 years old. Thus we are about to examine some ancient ideas of origin, some of which may antedate those of the *Rigveda*, which together with the Vedic notions were derived from still more ancient Aryan ideas.

The Iranian account of the creation is found in the first Fargard of the Vendidad. In this account, we find an opposition between Ahura Mazda, also called Ormazd, the creator of the good, and Angra Mainyu, also called Ahriman, the creator of that which is evil. Ormazd was conceived as living in a region of infinite light, and Ahriman as living in an abyss of endless darkness. When Ahriman came from the abyss and beheld the light of Ormazd, there was a conflict between the two. As Ormazd created excellent lands, Ahriman tried to despoil his work by bringing into being various plagues

We find in the *Zend-Avesta* significant ideas which throw much light upon the ancient Iranian ideas of origin In one place we are told that after Ahura Mazda had created his creatures which were to remain "three thousand years in a spiritual state, so that they were unthinking and unmoving, with intangible bodies" then Angra Mainyu came from his abyss into the light of Ormazd and a conflict continued between them for three periods of three thousand years each, or a total of nine thousand years. Thus Zoroastrian cosmogony really covers a period of twelve thousand years. During the first period of conflict, Ormazd was dominant; during the second

[9]Pike, A. "Lectures of the Arya," p 8, Louisville, 1930.

period, a period of bitter conflict, material things were created in the order: heaven (including heavenly bodies), water, earth, plants, animals and man; during the third period, the evil spirit spread disease and corruption in the good creation, but finally Ahriman and his hosts were driven back to hell. This dualism and conflict is characteristic of all Zoroastrian beliefs.

It has been pointed out that the spiritual creations of the first period of three thousand years—the period of the creation of the spiritual creatures of Ormazd—are remarkably like the "Ideas" of Plato Again we may note another parallel The conflict between Ormazd and Ahriman suggests the doctrine of Empedocles, who posited two world forces, love and hate, which were in conflict, and the triumph of love over hate was the cause of organic evolution. The same idea may be found among the Semites for whom creation was the result of a conflict in which order emerged out of chaos because of the personal triumph of the creator.

Sometimes these two opposing primeval spirits are referred to as twins, but this is not correct. Although Ahura Mazda is the good principle and Angra Mainyu the evil principle, the conflict is essentially between Cpenta-Mainyu the beneficent mind—the Good Mind—and Angra Mainyu. Since Cpenta-Mainyu is an emanation from Ahura Mazda, Ahura is above both Cpenta-Mainyu and Angra Mainyu. If this were not the case, the Evil Spirit would be equal with Ahura Mazda, and thus Ahura would not be the supreme Lord of Creation. Thus behind or beyond this conflict which results in material creation is Ahura Mazda whom the *Zend-Avesta* does not attempt to define Ahura Mazda was conceived as existing without beginning or ending, and that his essential characteristic was that he thought. "He never *began* to exist, so He never began to *create* To ***think***, with Him, is to *create*, and being, mind, intellect, wisdom, He never *was*, nor could be, without thought; to think, to exist, and to create, are with Him one and the same." Thus in the Gathas we find the doctrine clearly expressed, that the universe is the uttered thought of God We find further, that although Ahura Mazda is transcendent, he is also immanent in his creation and manifests himself in the material world.

We may say, then, that Zarathustra, the writer of the Gathas, conceived Ahura Mazda as the Infinite and Eternal One, the Creator, who although transcendent is immanent,

the Pure Light who did not create darkness but which the absence of light occasions. "By withdrawing Himself and His outflowing, He gave occasion for the darkness, which thus existed co-eternally with Himself, and uncreated like Himself, the twin of Cpenta-Mainyu, but not of the same father." Ahura Mazda, thus, must be conceived as the light—the hidden light—for if he had created light, or if his own existence had had a beginning, the darkness would have pre-existed eternally. Since this is not the case, Ahura Mazda remains supreme as the Eternal One, the source of creation whose thoughts becoming actual are the material world

Thus we find that the Iranians believed that the source-of-all-things is fundamentally a unity which, although itself uncognizable, makes itself manifest through its emanations. It is further significant that they believed that the essential nature of that from which all things come is thought

Since we have examined carefully and in detail the ideas of origin found among the ancient Indians and Iranians, let us here recapitulate the significant ideas which we found. Although the Vedic hymn, the "Hymn of Creation" (Rigveda X, 129), is the best source of ancient Indian ideas of origin which is available, we found significant ideas in other Vedic hymns even though they were couched in mythological terms One of the first things which we encountered in our study was a paradox, found not only in the more mythological hymns but in the "Hymn of Creation" as well, as to which came first, the gods or Heaven and Earth Sometimes the former are spoken of as creating the latter, and at other times as having been created by the latter. This paradox, however, was brushed aside by making Aditi, the Primordial Force of Nature, the source of all things. Aditi, we found, means "boundlessness" or the Boundless One, which immediately suggests Anaximander's idea of "the boundless" and the Egyptian Neb-er-tcher

Again we found the idea of design expressed for before the gods existed "Brahmanaspati like a smith together forged whatever is." Thus being from non-being came, and by some process of becoming, for the "spaces of the world" were born. The primacy of water we found was emphasized again and again. Certainly "the swelling flood" which was before the gods were established and from which they came, reminds us of Nu, the watery abyss of the Egyptians, of Thales, who posited water as the source of all things, of the Semites, of

Aristotle, and of the modern biologist. In this primal mass, a creative force lay hidden, an "embryo in which all the gods were aggregated"—the "Golden Germ" or egg—from which all things came by some process of becoming, a process by which that which was potential became actual. This idea of the potentiality of all things in an original germ was held by Augustine. The Egyptians labeled this idea Nu.

In the "Hymn of Creation," we found the tone more philosophical than mythological. Here we found the source-of-all-things to be conceived as impersonal—the "That One" or the "It" of creation We also found here emphasis laid upon the watery chaos, the darkness, from which "That One" came into being. Here also was creative force or power which manifested desire, the product of thought, which brought being from non-being. Thus thought is given a fundamental place in the Indian ideas of origin.

When we turned to the Iranian ideas of origin, we found conflict to be a fundamental idea, an idea which is not only peculiar to the mythological tales, but is likewise characteristic of the more philosophical notions. This conflict, a conflict between good and evil, resulted in the creation of the material world. Empedocles, we are reminded, posited love and hate which were in eternal conflict, which conflict resulted in the whole of creation. The Semites, likewise, conceived of two opposing world forces which were responsible for creation. Again the Iranians conceived Ormazd as light—the Pure Light. This suggests, among other ideas, the Egyptian "Vision of Hermes" in which the cry of light was symbolized as a flame—the primacy of fire.

Thus we must note in closing, that we have been dealing with ancient ideas of origin which antedate those of the Greeks, and which are not so far different in many respects from those which we have been accustomed to attribute to the originality of the lovers of wisdom of the Golden Age of Greece. We have discovered, as a result of our careful inquiry, that there is a peculiar, yet interesting, resemblance between the ideas of origin of the Ancients and those of Western thinkers. Many of the notions which are characteristic of the evolutionary thought of the nineteenth and twentieth centuries are also found, as we have pointed out above, in the cosmological speculations of the ancients.

THE EXTERNAL MORPHOLOGY OF ACRONEURIA EVOLUTA KLAPALEK.

(PERLIDAE, PLECOPTERA.)

ROBT L CLARK.
Waterford, Ohio

Stone flies are very primitive insects. Due to their poorly developed breathing apparatus the immature forms live largely in well-aerated water. This study was made principally at Stone Laboratory, Gibraltar Island, Put-in-Bay, Ohio, and the specimens used were collected along the rocky shores of the Lake Erie Archipelago, where the waves dashing upon the rocks furnished sufficient oxygen for their development.

Acroneuria evoluta is one of the medium sized varieties of the stone flies, the females having a length to tip of wings of 35 to 37 mm. and an expanse of 60 to 64 mm ; males, length to tip of wings, 25 to 28 mm., expanse, 42 to 48 mm. This genus is distributed over a wide area, being found in all parts of the United States and Canada

Realizing the importance of muscle attachments, the writer hoped to include such a discussion in this paper, but due to the season of the year in which this work was done and the correspondingly scarcity of material, it was impossible of accomplishment That phase will be taken up in a later paper.

This study was suggested by and made under the direction of Professor C. H. Kennedy, of Ohio State University, to whom the writer owes sincere thanks for his many helpful criticisms and suggestions Thanks are due, also, to Professor R E. Snodgrass, who looked over the drawings and helped in the naming of some of the parts.

THE HEAD.

(Pl. I, Figs. A, B, C, D, E)

The head of *Acroneuria evoluta*, family *Perlidae*, is wider than the prothorax, rather blunt in front at the labrum, and bears two long antennae. There is a dark area over the clypeus and also over the ocellar triangle. The frontal ridge is in the form of a broad letter "M." The head is capable of receding somewhat under the anterior edge of the pronotum. (Pl. I, Fig. A.)

The tentorium is braced in the back by two posterior tentorial arms, and extending forward from these are two arms which fit into the

lobes above the antennae and support the frontal region of the tentorium. (Pl I, Fig. B.)

The head appendages.—The labrum is flatly rounded in front and is covered with short hairs. The mandibles in the adult are poorly developed. The maxillae consist of sharp distigalea, lacinia, five-jointed palpus, stipes and cardo. The labium bears two three-jointed palps, between which are the paraglossae and glossae. These proceed out from the mentum The antennae consist each of approximately seventy segments, the basal joints being brown, followed by yellowish and darker segments toward the tips. The ocelli form an almost equilateral triangle, the hind ocelli quite larger than the fore, and closer to each other than to the eyes. (Pl. I, Fig. A.)

THE THORAX.

(Pl I, Figs 2, 3, and Pl II)

The prothorax is entirely covered dorsally by a plate-like pronotum. The pronotum is quadrangular, wider than long and narrows somewhat behind. The rugosities are rather strong and are yellow in a darker background Attached ventrally to the side edge of the pronotum is the anopleura, to which articulates the trochantin. (Pl. I, Fig. 2.) The coxa lies directly below the trochantin. The prosternum is composed of the basi-sternum, furca-sternum and spini-sternum These are fused together into more or less of a rigid plate The furcal pits are inclined toward the center and are joined in front by a furcal suture. (Pl. II, Fig 8) The two furcal spines (sternal apophyses, Pl. II, Fig. 5) are so wide apart that they do not appear as a median organ as in higher insects

The mesothorax extends forward dorsally to beneath the posterior edge of the pronotum by means of a prescutum which bears on the front a phragma (Pl I, Fig. 3.) The prealare (Figs 2, 3, 4, 6, 7, "Pa") extends down the side of the prothorax, almost touching the anterior edge of the episternum. In the membrane of the pleurum, between the prothorax and the mesothorax, lies the mesothoracic spiracle. (Pl. I, Fig. 2, "Sp2.") The mesopleurum is crossed obliquely by a heavy pleural suture (Pl. I, Figs. 2, 4), the lower end of which articulates with the coxa. Anterior to and below the pleural suture lies the episternum, posterior and above lies the epimeron By a finer suture, reaching the pleural suture at right angles the episternum is divided into an an-episternum and a kat-episternum (Pl. I, Fig 2) The small anterior sclerite of the an-episternum, known as the pre-episternum (Pl. I, Fig. 2, "PEps.") adjoins the prealare. At the base of the wing are several small plates and fused with the episternum is a crescent-shaped sclerite or basalare. (Pl. I, Figs. 2, 3, 4.) Posterior to this in the membrane are two plates, known collectively as the subalare. (Pl I, Figs 3, 4.) The wing articulates with the thorax by the anterior and posterior notal wing processes. (Pl. I, Figs. 3, 4.) The shield-shaped mesosternum consists of precoxal pieces on the sides with a basi-sternum, furca-sternum and spini-sternum in the center. The furcal pits are inclined toward the center as in the other two thoracic segments and are connected by the furcal suture. The

trochantin extends down from the pleurum and articulates with the coxa. A presternum lies in the membrane anterior to the mesosternum. (Pl. II, Fig. 5.) Both the prosternum and mesosternum bear narrow processes which lie in the membrane posterior to each (Pl. II, Fig. 5.) Lying posterior to the mesotergum is a postnotum which is fused with the tergum and extends laterally to the epimeron. (Pl I, Fig 2 and Pl. II, Fig. 6.) The postnotum bears a phragma posteriorly.

The metathorax bears a spiracle (Pl. I, Fig. 2, "Sp3") which lies in the membrane anterior to the metapleurum. The heavy pleural suture divides the pleurum into an episternum and epimeron The sclerites at the base of the hind wing are the subalare, basalare and the anterior and posterior notal wing processes. The postnotum of the metatergum bears the posterior phragma. (Pl. II, Fig 6.) The sternum of the metathorax is similar to that of the mesothorax except there is no sharp process in the membrane posterior to it

The wings—Among the species of the genus Acroneuria there is considerable variation in the number of crossveins in the outer submarginal fields of the wings, some having many and others none In the forewing the cubito-anal crossvein is close to the apex of the anal cell There are three anal veins unbranched, with two simple veins extending from the anal cell below (Pl III, Fig 9.) As in all genera of the order the radial sector of the hind wing at its base is fused with the median vein instead of the radius. The second anal vein is four-branched. (Pl III, Fig. 9)

The legs of adult stone flies, being similar to those of the immature forms, extend laterally from the side of the body when the insect is at rest, and are adapted for clinging to the surface of stones. Each leg has three tarsal segments. The terminal one is longest and carries on the end an oval pad and two sharp claws.

The Abdomen.

There are ten distinctly recognizable abdominal segments All but the first are slightly hardened and are more or less cylindrical in shape. In each the tergite and sternite are closely fused at the sides, forming a narrow fold. Segment one is greatly reduced, appearing merely as a small rectangular dorsal sclerite. The pleural region of segment one is replaced by the attachment of the hind legs, and the ventral sclerite is lacking, being completely fused with the metasternum and the sternite of segment two A surviving trace of an eleventh segment is found in the supra-anal plate of the female and the sub-anal lobes of the male These will be discussed further as a part of the genital region."

The Genital Organs.

(Pl. III, Figs 10 to 17)

There are ten abdominal segments, the ninth segment in the male bearing on its dorsal side an oval, transverse, polished hammer; and on the tenth segment, between the cerci, two subanal lobes modified into sharp, cylindrical, genital hooks. (Pl. III, Figs. 10, 11) These extend forward ventrally to the middle of the tenth segment. The

abdomen is covered with short hairs and on the ventral surface of each of segments nine and ten are two patches of short spines. The penis extends from the end of the abdomen as in figure fourteen.

"The eighth ventral segment of the female is produced in the middle into a rather narrow subgenital plate which reaches half way across segment nine. The plate is slightly emarginate behind and having slight emarginations on the sides of the plate at the base."[1] At the end of the abdomen of the female, between the cerci, is a supra-anal plate which is a triangular protrusion of segment ten covering the anal cavity above. (Pl III, Figs. 15, 16, "SAP.") Between the cerci are the subanal lobes or paraprocts. (Pl. III, Fig. 15, "Papt.") The cerci bear nineteen segments.

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[1]"Plecoptera of North America," by Needham and Claassen

EXPLANATION OF PLATES.

PLATE I.

Fig. 1. A, Head, dorsal view. B, Same as above, posterior view. C, Maxillae, showing five-jointed palps. D, Mandible E, Labium.
Fig 2. Lateral view of thorax region
Fig. 3. Ventral surface of mesotergum and upper pleural regions.

PLATE II.

Fig. 5. Inner surface of mesotergum
Fig. 6. Inside view of metatergum showing anterior and posterior phragmas.
Fig. 7. Dorsal view of thorax.
Fig. 8. Ventral view of thorax.

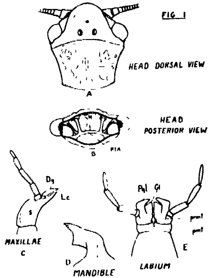
PLATE III

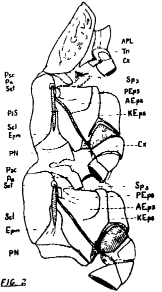
Fig. 9. Wings of *Acroneuria evoluta*.
Fig. 10 Ventral view of segments 8, 9 and 10 of the male, showing genital hooks.
Fig. 11. Tenth segment, male, showing genital hooks, posterior view.
Fig. 12 Lateral view of segment 9, male
Fig. 13. Same as above, posterior view, showing hammer
Fig. 14 End of abdomen, male with penis extended
Fig. 15 End of abdomen, female, ventral view, showing subanal lobes (paraprocts), and supra-anal plate.
Fig. 16. Segment 10, female, ventral view, showing supra-anal plate as a part of the segment
Fig. 17 Sternum of segment 8, showing genital plate.

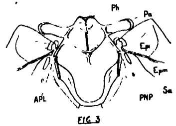
ABBREVIATIONS USED.

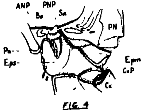
AEps	an-episternum	PlS	pleural suture
An	Anus	PN	postnotum
ANP	anterior notal wing process	PNP	posterior notal wing process
APL	anapleura	pmt	post mentum
Ba	basalare	prmt	prementum
Bs	basisternum	prs	presternum
Cer	cercus	Psc	prescutum
Cx	coxa	PTA	posterior tentorial arm
Dg	distigalea	s	stipes
Epm	epimeron	Sa	subalare
Eps	episternum	SAL	subanal lobe
Fs	furcal suture	SAP	supra-anal lobe
Gl	Glossa	Scl	scutellum
h	genital hook	Sct	scutum
ha	hammer	SGP	subgenital plate
KEps	kat-episternum	Sp	spiracle
Lc	lacinia	Ss	spini-sternum
Pa	prealare	Stn	sternum
Papt.	paraproct	T	tergum
PEps	pre-episternum	Tg	tegula
Pgl	paraglossa	Tn	trochantin
Ph	phragma	Tr	trochanter

Acroneuria evoluta
Robt. L Clark









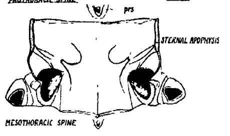


FIG 5

INNER SURFACE OF MESOSTERNUM

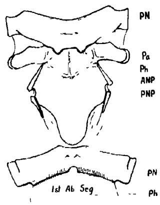


FIG 6

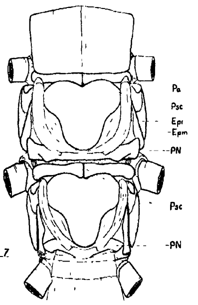


FIG 7

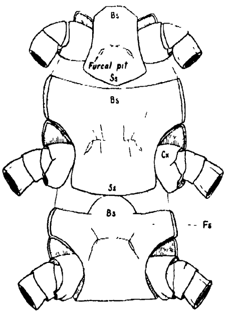


FIG 8

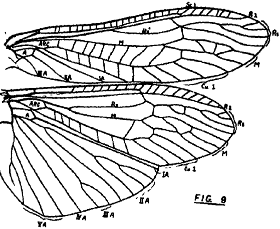


FIG. 9

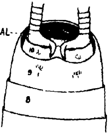


FIG. 10

FIG. 11

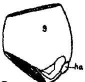


FIG. 12

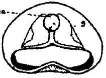


FIG. 13

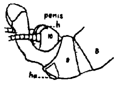


FIG. 14

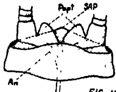


FIG. 15

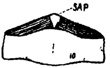


FIG. 16

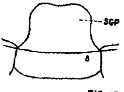


FIG. 17

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A STUDY OF THE INSECT FAUNA OF A CONIFEROUS REFORESTATION AREA IN SOUTHEASTERN OHIO[1]

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INTRODUCTION

Considerable interest has recently been manifested in the reforestation of certain areas of southeastern Ohio. The outstanding projects have been conducted with coniferous trees. Scattered conifers have been present in this region for many years, but with more extensive and concentrated plantings the insect pest problem assumes a seriousness not present with isolated trees or very small plantings.

York Forest, a reforested area in Athens County, was selected for this study because of its convenience and representative character. A brief account of the history and make-up of the forest appears elsewhere in this paper.

Based on York Forest as being a representative reforested area in the region under consideration, the scope of this study has been to determine what insects of the coniferous association had established themselves in the area, the extent of their damage, the probable or possible sources from which they entered, and the possibilities of appearance of pests not now known to be present.

Weekly inspection trips were made during the spring, summer, and autumn months of 1932. Areas in which outbreaks of pests had occurred were visited each time, the progress of infestations was noted, and the entire forest was scouted for developments pertinent to this survey.

The writer wishes to express his appreciation of the assistance rendered in the investigation by the following. Dr. Wm. C Stehr, under whose guidance the study was made; Dr.

[1]Paper No 6 from the Department of Biology, Ohio University. Presented in partial fulfillment of the requirements of the degree of Master of Arts.

Frederick H. Krecker and the Biology Department of Ohio University, who made the investigation possible; Dr. Harold Morrison, R. A. Cushman, and L. H. Weld, of the United States Bureau of Entomology, Mr. A. N. Tissot of the University of Florida, Dr. Herbert Osborn and Dr. Raymond C. Osburn, of Ohio State University, who identified many of the insects discussed in the report; and Mr. M. H. Doolittle, Superintendent of the Carbondale Coal Co, who generously gave permission to investigate the forest and supplied important details of history and personal observations during the existence of the forest.

HISTORY AND MAKE-UP OF THE FOREST

The forest upon which this investigation was conducted is known as the York Forest located in the northwestern corner of Waterloo township, Athens County, Ohio. It is a reforestation project carried out by the Carbondale Coal Co. on a hilly area characterized by deep ravines and steep slopes. The soil is a sandy loam, and the slopes contained many gullies as a result of the erosive action following the removal of the original deciduous forest.

Reforestation activities were begun by planting the eroded areas to black locust and tulip poplar in 1906 as a reclamation measure. The preliminary work proved quite satisfactory, and the first conifers were planted in 1908. Practically all the planting was done during the spring seasons. Fall planting was tried but did not give satisfactory results. Planting was done annually from 1908 to 1928 inclusive, except in the year 1913.

The forest now consists of about 200 acres divided into two main portions—the older containing about 160 acres, and the newer about 40 acres. The newer planting was laid out with the aim of harvesting the timber, in contrast to a rather experimental and crowded system of planting in the older area where land reclamation was the chief object. The coniferous tree population averages about 8,000–9,000 trees per acre.

The coniferous species represented are as follows:

COMMON NAME	SCIENTIFIC NAME
White pine	*Pinus strobus*
Red pine	*Pinus resinosa*
Scotch pine	*Pinus sylvestris*
Jack pine	*Pinus banksiana*

Austrian pine	*Pinus austriaca*
Southern longleaf pine	*Pinus palustris*
Larch	*Larix* spp.
Fir	*Abies* spp.
Spruce	*Picea* spp.
White Cedar	*Thuya occidentalis*
Bald cypress	*Taxodium distichium*

White pine, red pine, and Scotch pine are the most abundant trees in the forest.

INSECTS OF THE CONIFEROUS ASSOCIATION IN YORK FOREST

In the course of this investigation, a considerable number of insect species was found in the forest whose habits and ecology indicated that they were members of the coniferous forest association.

The following list includes only those species which are definitely members of this forest association, or importantly concerned with the life of the forest. The writer feels that the list is in no sense an exhaustive one, but it does contain many forms of vital importance to the planting. The identifications are to species in most cases.

ORDER ORTHOPTERA
  Family Gryllidae
    Oecanthus pini Beutm.

ORDER ISOPTERA
  Family Rhinotermitidae
    Reticulitermes sp.

ORDER NEUROPTERA
  Family Hemerobiidae
    Hemerobius sp.
  Family Chrysopidae
    Chrysopa sp.

ORDER HEMIPTERA
  Family Reduviidae
    Pselliopus cinctus (Fab.)
    Arilus cristatus (L.)
  Family Ploiariidae
    Emesaya brevipennis (Say)
  Family Pentatomidae
    Euschistus tristigmus (Say)
    E. variolarius (P. de B.)
    Brochymena quadripustulata (Fab.)

ORDER HOMOPTERA
  Family Cercopidae
    Aphrophora parallela Say
  Family Aphididae
    Cinara sp.
  Family Pylloxeridae
    Adelges pinicorticis (Fitch)
  Family Coccidae
    Chionaspis pinifoliae Fitch

ORDER COLEOPTERA
  Family Histeridae
    Epierus regularis Beauv.
  Family Coccinellidae
    Chilocorus bivulnerus Muls.
  Family Curculionidae
    Cossonus corticola Say
    Pissodes approximatus Hopk.
  Family Cerambycidae
    Monochamus confusor Kirby
    Rhagium lineatum Oliv.
    Leptostylus sexguttata Say
  Family Scolytidae
    Pityogenes punctipennis Lec.
    Ips calligraphus Germ.

ORDER LEPIDOPTERA
Family Psychidae
Thyridopterix ephemeraeformis Haw.
Family Sphingidae
Lepara coniferarum (A. & S.)

ORDER DIPTERA
Family Syrphidae
Syrphus torvus (L.)
S. rectus (O. Sacken)
S. weidemanni Johnson

ORDER HYMENOPTERA
Family Ichneumonidae
Ophion bilineatum Say
Ophion sp. (near *idoneum* Vier.)
Anacharis sp.

The following paragraphs summarize the activities of the insects of the preceding list in York Forest.

Oecanthus pini Beutm. (Pine tree cricket).

All of the specimens of *O. pini* taken in York Forest were on *Pinus strobus*. They were found in considerable numbers on the trunks of the trees on cold mornings in the early fall. This insect lays its eggs in the twigs of the trees and thus no doubt causes some injury. According to Blatchley (1920) its injury may be offset by its beneficial activities in feeding on aphids and other insect pests.

Aphrophora parallela Say (Pine spittle bug).

During the midsummer season these spittle insects were abundant on the Scotch pine. However, they disappeared early and there was no evidence of any damage resulting from their activity. The determination was made by Dr. Herbert Osborn, who stated in a personal communication that it is spread over the whole coniferous area of the eastern United States.

Cinara sp. (Aphids)

Two small colonies of aphids were found on young Norway spruce. However, no further infestation by these insects was found, so they can not be considered serious pests at York Forest.

Adelges pinicorticis (Fitch) (White pine aphid).

This insect secretes a flocculent, waxy material which covers both insect and egg By the end of the summer, the infestation of *A. pinicorticis* had become abundant in spots and gave evidence of becoming a serious pest. According to Houser (1918), "Pines attacked by this aphis become sickly, the needles turn yellow, limbs may die and occasionally the entire tree succumbs. As a rule, however, only the smaller trees die."

In an area in which both recently trimmed and untrimmed white pines, between the ages of fifteen and twenty years were growing adjacent to each other, it seemed that the trimmed trees were more frequently attacked by the adelgid and that the degree of infestation was, in general, heavier on the trimmed trees. Counts were made which verified these observations and the data are presented in Table I above as for Area I.

A total of 667 trimmed and 223 untrimmed white pines were examined for adelgid attack in Area I. The contrast is very marked

as will be seen by an examination of the figures of Table I. In the trimmed pine, 16.9% had a heavy infestation, while only 1.34% of the untrimmed pine had a heavy infestation Of the trimmed trees, 15 3% had a medium heavy infestation, whereas only 4.49% of the untrimmed trees were so infested. Thirty-nine per cent of the trimmed trees had a light infestation and 43% of the untrimmed trees had a similar infestation. While 51% of the untrimmed trees were not infested, only 28 4% of the trimmed trees were free from infestation It is interesting to note that most of the untrimmed trees attacked by the adelgid were at the edge of the fire lane separating the trimmed and untrimmed portions.

TABLE I

Showing the Comparative Infestation of *Adelges pinicorticis* (Fitch) on Trimmed and Untrimmed *Pinus strobus*

		Area I Trimmed White Pine	Area I Untrimmed White Pine	Area II Trimmed White Pine
Heavy Infestation	No of trees	113	3	23
	Percent of Total	16 9	1 34	5 5
Medium Infestation	No of trees	102	10	5
	Percent of Total	15 3	4 49	1 2
Light Infestation	No of trees	263	96	67
	Percent of Total	39 4	43 05	15 9
Free	No of trees	189	114	326
	Percent of Total	28 4	51 12	77 3
Total	No of trees	667	223	420
	Percent of Total	100	100	100

By referring to Table I again, it will be noted that the trimmed white pines of the isolated plot, designated as Area II, were, on the whole, less frequently and less severely attacked than the trimmed white pines of Area I. There are several factors worthy of note in this connection. The trees of Area II are a few years older than those of Area I, and are also more widely spaced, allowing more sunlight to penetrate to the trunks Further, Area I is on a gradual southeast slope and Area II is on a similar northeast slope. From the present data, these are the only apparent differences in the areas, but whether they actually affect the infestations of adelgids in any way can not be determined from the studies up to the present time.

When the adelgid infestation was at its height, syrphid larvae were numerous on the trunks of infested trees. Three species of adult syrphids, *Syrphus torvus* (L), *S. rectus* (O. Sacken), and *S. weidemanni*

Johnson were taken in the forest. Dr. R. C. Osburn, who made the identifications, stated in a personal communication that "these species are all aphid feeding," so, evidently, they are aiding in the control of the adelgid, but are not abundant enough to establish complete control.

Chionaspis pinifoliae Fitch (Pine leaf scale).

In York Forest, the occurrence of *C. pinifoliae* was very extensive among the older white pines and red pines. On these older trees the infestation was confined, for the most part, to the lower branches which were in the self-pruning process. Younger trees were rarely attacked The pest is abundant enough to be considered one of the serious pests at York Forest

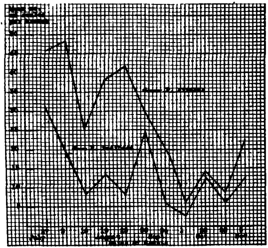

FIG 1 Mean number of pine leaf scales, *Chionaspis pinifoliae* Fitch, on terminal twelve inches of white pine, *Pinus strobus*, and red pine, *Pinus resinosa*, as determined by weekly counts

During the summer and early fall months, weekly counts were made for the purpose of following the progress of the scale infestation. Counts were made of the number of scales on the terminal twelve inches of five branches located on various sides of each tree The number of trees counted varied from eight to twenty and they were selected from various points throughout the area of infestation. The graphs of Figure 1 below show the seasonal progress of the scale as indicated by these counts.

Referring to the curves of Figure 1, it will be seen that the seasonal curve of the pine leaf scale has the same general form for both white pine and red pine. The rapid rise of the curves in August would seem to indicate the emergence of another brood and also to indicate that Houser's observation that there are two broods per year in Ohio is probably true in Southeastern Ohio unless the November rise indicates the emergence of another small brood. Generally speaking, the curve fell rapidly with the approach of autumn and consequent shedding of needles from the lower branches.

The twice-stabbed lady beetle, *Chilocorus bivulnerus* Muls., was fairly abundant on both white pines and red pines, and was observed actively feeding on the scales. However, the lady beetle was not sufficiently abundant to control the scale. The scale infestation has spread over a large part of the older planting, and there is a possibility of its causing considerable damage in the future.

Houser (1918) gives the following information concerning the seriousness of *C. pinifoliae*.

"The needles only of the host are attacked and when the infestation is only moderate no very serious results attend the pest. When the attack is severe, the needles become yellow and parts or the entire tree may die."

Cossonus corticola Say (Weevil)

C. corticola, a secondary pest, was common in the bark of dead pine trees in York Forest, but was of no especial importance except as a member of the coniferous association, working under the bark of dead timber

Pissodes approximatus Hopk. (Weevil)

P approximatus has been commonly confused with the very destructive *P strobi* Peck, but was established as a separate species by Hopkins (1911). Of its list of hosts, *Pinus strobus* and *P. resinosa* are present in York and the insect was found beneath the bark of young trees of these species It was not abundant, but may become a serious pest of young pines in the future.

Monochamus confusor Kirby (*notatus* Dr).

The adults of this genus, known as "sawyers," deposit their eggs in the bark of dead and dying coniferous trees and logs. The larvae which work in the inner bark and sapwood were plentiful in dying white pines in York Forest. Their damage is of a secondary nature, rendering killed trees of this planting useless as lumber.

Rhagium lineatum Olivier (Ribbed pine borer).

Adults and larvae of this secondary insect were found beneath the bark of dead pine, a common habitat for it in West Virginia, according to Hopkins (1893b). Felt (1930) does not consider *R. lineatum* especially injurious.

Leptostylus sexguttatus Say.

Hopkins (1893b) does not list this Cerambycid borer from West Virginia. A few specimens were found beneath the bark of dead white pine in York Forest Blatchley (1910) records this insect from Kosciusko County, Indiana, and adds that its occurrence there is "rare."

Pityogenes punctipennis Lec.

P. punctipennis was by far the most important beetle attacking young pines in York Forest. Six young white pines, thirteen young Scotch pines, and four young jack pines had evidently been killed by this bark beetle attack. None of these trees appeared to be more than ten years of age. Large numbers of adult *P. punctipennis* were present under the bark of these trees.

Thyridopterix ephemeraeformis Haworth (Evergreen bagworm).

In York Forest, this insect attacked arbor vitae and larch, but not in sufficient numbers to be considered a serious pest.

Lepara coniferarum A. & S. (Abbott's pine sphinx).

Only one specimen of this moth was taken, and no larvae at all were observed in York Forest. The larvae feed upon pine foliage.

Hemerobius sp. (Brown lacewings) and *Chrysopa* sp (Green lacewings).

Throughout the summer months these lacewings were abundant in the planting The brown lacewings were more abundant in the earlier part of summer and the green lacewings were more abundant in mid-summer. The larvae of both of these genera are predaceous on aphids, scales and other small insects.

Emesaya brevipennis (Say) (Thread-legged bug).

This member of the family Ploiariidae was fairly abundant in York Forest. It is known to be a predator on small insects.

Pselliopus cinctus (Fab).

Specimens of *P. cinctus* were taken frequently throughout the forest. They were actively running about over the trunks of the pines. This insect is known to be a predaceous form and was probably preying upon small insects found on the pines and other vegetation of the forest.

Arilus cristatus (L.) (Wheel-bug).

During this investigation, specimens of *A. cristatus* were observed frequently upon the pines where they probably aid somewhat in control of pests, although they possibly attack beneficial forms, too According to Graham (1929) the nymphs of the wheel-bug are predaceous upon aphids and other small insects and as they mature they attack larger insects.

Brochymena quadripustulata (Fab.)

This "stink-bug" was abundant on white pine and Scotch pine and may have been feeding on sap However, it is known to be predaceous on tussock moths and brown-tail moths. Felt (1908) records spruce and fir as being attacked by the white-marked tussock moth (*Hemerocampa leucostigma* A. & S), and Houser (1918) reports this moth as doing damage in southern Ohio. In view of these facts, the presence of *B. quadripustulata* is worthy of note, even though the white marked tossuck moth was not found in York Forest.

Chilocorus bivulnerus Muls. (Twice-stabbed lady beetle).

C. bivulnerus was found in considerable numbers, feeding on *Chionaspis pinifoliae* Fitch. The seasonal progress of the scale showed that the lady beetle was not abundant enough to completely control the scale. However, the evidence shows that it is aiding in the control of the scale and must be considered of positive economic importance in the planting.

Syrphus spp. (Syrphid flies).

Throughout the spring and summer months, syrphid flies were abundant in York Forest. The species taken were *Syrphus torvus* (L.),

S. rectus (O. Sacken), and *S. weidemanni* Johnson. Dr R. C. Osburn, who made the identifications, stated in a personal communication that all of these species are aphidophagus. Many syrphid larvae were found feeding on the adelgid, *A. pinicorticis* (Fitch), and, although they did not control the pest, they were undoubtedly aiding in its control.

Ophion bilineatum Say; *Ophion* sp. (near *idoneum* Vier.).

These Ichneumonids were quite abundant in York Forest during the summer, but no evidence of their parasitic habits was seen. However, R. A. Cushman states in a personal communication that they are parasites on lepidopterous larvae. Their abundance would make them valuable aids in controlling certain lepidopterous pests that might appear in the planting.

Anacharis sp.

This Hymenopteron was not as abundant as the above species. It was not observed parasitizing any other insects, but, according to information in a personal communication from L. H. Weld, they are parasitic on *Chrysopa* and *Hemerobius* larvae. Inasmuch as *Chrysopa* and *Hemerobius* are predaceous on harmful insects, *Anacharis* is evidently of negative economic importance in York Forest.

Reticulitermes sp. (Termites).

After the pine trees had died, termites were found mining in their trunks. They may be considered of negative economic importance in this forest because their activity contributes toward making the wood unfit for utilization as lumber.

Euschistus spp. (Stink-bugs).

E. tristigmus and *E variolarius* were fairly abundant in York Forest They feed on various weeds and vegetables, but there was no evidence of their attacking the pines.

Epierus regularis (Beauv) (Hister beetle)

This histerid beetle was present in small numbers under the bark of dead trees. Blatchley (1910) says it feeds on fungi and since there is always considerable fungus under such bark, this no doubt explains the presence of beetles.

Camponotus sp. (Carpenter ants)

After the death of the pine trees, evidences of the work of carpenter ants were noted in the trunks. They contribute to the destruction of the tree trunks and make the dead timber unfit for lumber.

ECOLOGICAL SUCCESSION OF INSECTS IN PINUS STROBUS

The observations at York Forest have made it possible to determine the ecological succession in the white pine, ***Pinus strobus***, growing in this area.

It seems that younger pines, less than ten years of age are seldom attacked by insect pests in York Forest. Most of

the attacks occurred on the older trees of the planting between the ages of fifteen and twenty years. The trunks of these trees varied in diameter from three or four inches to ten or twelve inches, and there seemed to be no correlation between the size of the trunk and insect attack

Evidently, the first attack is made by the bark beetle, *Pityogenes punctipennis* Lec., followed a short time later by the weevil, *Pissodes approximatus* Hopk and the borers *Leptostylus sexguttata* Say, *Monochamus confusor* Kirby, and *Rhagium lineatum* Oliv At a still later stage, *Ips calligraphus*

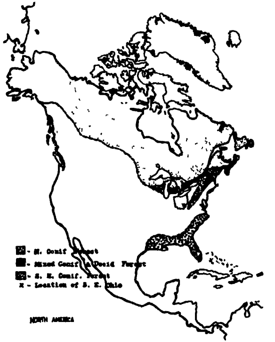

FIG 2. Location of southeastern Ohio with reference to main coniferous areas of eastern United States

Germar and *Cossonus corticola* are in evidence. Shortly after, the histerid beetle, *Epierus regularis* Beauv. is active under the bark, feeding upon the fungus present there. Still later, carpenter ants, *Camponotus* sp. and white ants, *Reticulitermes* sp. begin work in the trunk. When the trunk is reduced to a mass of debris, centipedes and spiders are active, probably feeding upon various small organisms seeking food and shelter in this material.

COMPARISON OF THE INSECT FAUNA OF YORK FOREST WITH THAT OF OTHER CONIFEROUS AREAS

Reference to Figure 2 will show that southeastern Ohio lies near the center of a loop formed by the coniferous areas on the north, east, and south of Ohio, and insects coming into York Forest might originate from one or more of these areas Table II has been prepared on the basis of data obtained from the works of Hopkins (1893a, 1893b, 1909), Felt (1930), Peirson 1927), Houser (1918), Blackman (1922), Blatchley (1910), Blatchley and Leng (1916), and Craighead and Middleton (1930) This table shows the principal coniferous insect pests in the above areas, their distribution, hosts, type and extent of injury, and the possibility of their occurrence in southeastern Ohio and York Forest if they are not already present.

Sixty-five insect pests are listed in Table II, the ranges of which are principally northern and northeastern, many of them extending into West Virginia Ten of these pests, indicated by the letter "y", are definitely established in York Forest and an eleventh is present in Athens County

Referring again to the distribution records of the species in Table II, it will be noted that thirty-eight species not taken in York Forest, have such distribution records as to render their occurrence in this section of Ohio probable either now or at some future time. These species are indicated by the letter "a" in the table

The white-marked tussock moth, *Hemerocampa leucostigma* S & A , is present in Athens County, but was not observed in the York planting

Other insects that will probably appear here are the bark-beetles *Dendroctonus valens* Lec., *D tenebrans* Oliv., *Ips grandicollis* Eich., and *I. caelatus* (Eich), the very serious white pine weevil, *Pissodes strobi* Peck., and the destructive pales weevil, *Hylobius pales* Boh. These are recorded from West Virginia by Hopkins (1893a, 1893b) and Blatchley and Leng (1916).

Further examination of Table II shows certain pests, indicated by the letter "b", that are not now in the immediate vicinity of southeastern Ohio, but which may find their way into this region. This group includes the Nantucket pine moth, *Rhyacionia frustrana* Comst., a pest of young pines, the bark-beetles *Ips avulsus* (Eich), *Ips pini* (Say), and *Pityophthorus pulicarius* Lec., the weevils *Pissodes similis* Hopk. and *P dubius* Rand., and the borer, *Buprestis maculiventris* Say.

TABLE II.

THE PRINCIPAL CONIFEROUS INSECTS PESTS OF EASTERN NORTH AMERICA.

Species	Hosts	Type and Extent of Injury	Distribution	Possible Occurrence in S. E. Ohio
ORDER HOMOPTERA				
Family Coccidae				
Chionaspis pinifoliae Fitch	Pines, spruces	Scale insect on needles	Most of Northern U. S.	y
Family Phylloxeridae				
Adelges pinicorticis (Fitch)	White pine	Sap feeder on trunks	Northern U. S. to Minn.	y
Adelges abietis (L.)	Spruces, fir	Gall former	Range of spruce and fir	a
Adelges cooleyi (Gillette)	Spruce, fir	Gall former	Range of spruce and fir	a
Family Cercopidae				
Aphrophora parallella (Say)	Hard pine	Suck juices of leaves	Coniferous area of eastern U. S.	y
ORDER COLEOPTERA				
Family Buprestidae				
Chrysobothris azurea Lec.	Pine	Bark and wood borer, dead trees	West Virginia and Indiana	a
Buprestis maculiventris Say	Spruce	Borer	Indiana, Northeastern U. S.	b
Chalcophora virginiensis Drury	Pine, spruce	Borer	Eastern and Central U. S.	a
Chalcophora liberta Germ.	Pine, spruce	Borer	Eastern and Central U. S.	a
Family Cerambycidae				
Prionus laticollis Drury	Pine stumps	Borer	West Virginia and Indiana	a
Asemum moestum Hald.	Pine, spruce	Borer	Eastern U. S. and W. Va.	a
Phymatodes dimidiatus Kirby	Spruce	Bark borer	West Virginia	a
Callidium antennatum Newm.	Pines	Wood borer, dead & dying trees	West Virginia and Indiana	a
Rhagium lineatum Oliv.	Pines	Bark borer, dead & dying trees	West Virginia and Indiana	y
Monochamus scutellatus Say	Pine	Wood borer, logs, dead and dying trees	West Virginia and Indiana	a
M. confusor Kirby	Pine, spruce	Borer in logs and dying trees	Can., N. Eng. and Middle States	y
M. marmator Kirby	Pines	Borer, kills living fir trees	N. Eng., W. Va.	a
M. titillator Fab.	Pine, fir	Borer	N. Eng., Ind., W. Va. and S. E. U. S.	a

TABLE II—Continued

Species	Hosts	Type and Extent of Injury	Distribution	Possible Occurrence in S. E. Ohio
Family Pythidae				
Pytho niger Kirby	Pine, spruce	Bark borer, dead & dying trees	West Virginia	a
P. americanus Kirby	Pine	Bark borer, logs	West Virginia	a
Family Curculionidae				
Pissodes strobi Peck	Pine, spruce	Bark borer, young, living and dying trees	Northeastern U S, W Va, Ohio	a
P. approximatus Hopk	Pines	Larvae live in bark of saplings	Eastern U S	y
P affinis Rand	White pine	Weevil lives in bark of stumps	Northern U. S	?
P similis Hopk	Fir	Infests branches	Maine, N H, N Car	b
P dubius Rand	Fir	Barks, living and dying stumps, trees	Ontario, Maine to Michigan	b
Hylobius pales Boh	Pines	Feeds on inner bark	N Eng to Florida and Ind	a
Family Scolytidae				
Monarthrum fasciatum Say	Many conifers	Tunnels in wood, enemy of products	Quebec and Lake Superior to Florida, West Virginia	a
M mali Fitch	Many conifers	Tunnels in wood and products	Eastern U S, Ontario to Fla.	a
Gnathotrichus metarsarus Fitch	Pines	Timber beetle, dying pine	Eastern U S, Canada to Fla	a
Pityogenes pullus (Zimm)	Pines	Under bark of dying pine	S Car, Mich, W. Va, N. Y, N. J, D C	a
P. hopkinsi Swaine	White pine	Bark miner	Throughout spruce region of W Va	a
Family Scolytidae				
Pityogenes punctipennis Lec	Spruce, fir, pine	Miner, green bark, top of living tree	Maine and Quebec to Mich, W Va	y
P. plagiatus (Lec)	Pines	Tops and branches	Miss, Fla, D C	b
Pityophthorus annectans Lec	Pine	Bark beetle	Fla, W Va, D C	a
P. sparsus Lec	White pine, etc	Bark beetle, hastens death of trees	W Va	a
P. pulicarius Zimm	Pine	Twig beetle	N J to Fla, Ill., S Car	b
P. consperda Schwarz	Pine cones	Cone beetle	Canada, Mich, Mass, Va, N Y, Pa	b

TABLE II—Continued.

Species	Hosts	Type and Extent of Injury	Distribution	Possible Occurrence in S E Ohio
P lautus Eich	Pines	Mines under bark of branches and twigs	W Va., Miss, Texas	a
Xyloterus scabriolus (Lec)	Dying pines	Timber beetle	Quebec, D C, W. Va, N Y., New Mex	a
Dryocoetes autographus Ratz	Spruce	Bark, hastens death of injured tree	W Va	a
Ips grandicollis Eich	Pine, spruce	Bark beetle	Middle Atlantic, Southern and Western States	a
I calligraphus (Germ)	All pine	Bark beetle, hastens death of trees	Canada, Atlantic region to Mex	y
I cacographus (Lec)	Pines, spruce	Bark beetle, hastens death of tree	W Va	a
I pini (Say)	Pines	Bark hastens death of injured and dying tree	Eastern U S and Canada	b
I avulsus (Eich)	Pines	Bark hastens death of injured and dying tree	Southern U S, Penn.	b
I caelatus (Eich)	All pines, spruce	Bark, hastens death of dying trees	U S south to W Va	a
Dendroctonus valens Lec	Pine, larch, fir	Bark beetle	Canada, New Eng, south to N Car	a
D tenebrans Oliv	Pines	Bark beetle, may be primary	N H, Penn., Tex, Fla, W. Va	a
D piceaperda Hopk	Spruce	Bark beetle	Maine, Mich, N H., Penn, Canada	?
Crypturgus pusillus Gyll	Pines, spruce	Bark beetle, hastens death of trees	Northeastern U S, Can, W Va	a
Hylurgops glabratus Zett	Pines	Bark beetle, hastens death of trees	W Va	a
H pinifex Fitch	Spruce, pine	Bark beetle, hastens death of trees	Canada, New Jersey, Ohio	a
Polygraphus rufipennis Kirby	Spruce	Miner, important secondary enemy	Throughout spruce region, W Va	a

TABLE II—Continued.

Species	Hosts	Type and Extent of Injury	Distribution	Possible Occurrence in S. E Ohio
ORDER LEPIDOPTERA				
Family Tortricidae				
Cacoecia fumiferana Clem	Spruce, fir	Defoliating larvae	Northern states, Canada	?
Family Lymantriidae				
Porthetria dispar L	Most trees, pines	Defoliating larvae	Eastern and Middle West	a
Hemerocampa leucostigma S & A	Most trees, spruces, fir, larch	Defoliating larvae	Eastern U S, Miss valley	y
Family Psychidae				
Thyridopterix ephemeraeformis Haw	Cedar, larch	Defoliating insect	Ohio, Eastern U S	y
Family Olethreutidae				
Rhyacionia buoliana Schiff	Most pines	Defoliating larvae	N Eng, Middle West, Ohio	a
R frustrana Comst	Pines	Defoliating larvae	Eastern and Southern States	b
Family Coleophoridae				
Coleophora laricella Hbn	Larch	Defoliating insect	N Eng, Lake States, Canada	b
ORDER HYMENOPTERA				
Family Tenthredinidae				
Diprion abbotti (Leach)	Pines	Defoliating insect	Eastern and East Central U S, Ohio	a
Neodiprion lecontei (Fitch)	Pines	Defoliating insect, kills trees	Eastern U S and West to Wis	a
Family Formicidae				
Formica exsectoides Forel	Pines	Eject formic acid, kill trees	Northeastern U S	?
Camponotus herculeansis pennsylvanicus DeG	Many trees, pines	Tunnel in living trees, logs, forest products	Throughout U S	y

There are a few pests listed in Table II whose distribution records make it seem unlikely that they will appear in southeastern Ohio in the near future. *Pissodes affinis* Rand., *Dendroctonus piccaperda* Hopkins, and *Cacoecia fumiferana* Clem. are examples.

In summarizing, we may say that the known distribution and habits of most of the sixty-five pests listed in Table II indicate that most of them are potential enemies of conifers in southeastern Ohio. Ten of these species have been taken at York Forest, and one other is known from Athens County. It is highly probable that still others are now present in this region. Most of the sixty-five species have been recorded from West Virginia A close study of the table leads to the conclusion that West Virginia and southeastern Ohio are at a focal point for the meeting of the insect faunas of the northern and northeastern, and to a lesser degree, the southern coniferous areas of the eastern United States Judging from present distribution records and duplication of the coniferous insect fauna of West Virginia and southeastern Ohio, it is probable that natural infestation of southeastern Ohio forests occurs frequently by migration from the West Virginia coniferous areas. This does not preclude the possibility of introduction of pests from other regions at greater distances by commerce in wood products of all kinds, Christmas trees, etc., or with young trees for reforestation.

GENERAL REMARKS AND CONCLUSIONS

This investigation has made it clear that a coniferous insect fauna is established in York Forest in which there are both harmful and beneficial species. Although the present study has been chiefly qualitative in nature, such quantitative data as have been accumulated show that several serious pests are at present doing considerable damage. An analysis of the insect pest fauna of the principal coniferous areas of eastern United States reveals numerous other injurious species which will probably migrate into southeastern Ohio and York Forest. It is evident that future reforestation activities in this area must take into account the insect problems that may arise.

The present data seem to warrant the following conclusions.

(1) Some thirty species of insects that are definitely members

of the coniferous forest association have established themselves in York Forest.

(2) Of these insects, the following pests are abundant enough to be of economic importance *Pityogenes punctipennis* Lec., Adelges *pinicorticis* (Fitch), and *Chionaspis pinifoliae* Fitch.

(3) The following beneficial insects are present and aiding in control: *Chrysopa* sp, *Hemerobius* sp, *Chilocorus bivulnerus* Muls, and *Syrphus* spp

(4) The trees most seriously affected by insect attacks are *Pinus strobus* (white pine), *Pinus sylvestris* (Scotch pine), *Pinus banksiana* (Jack pine), in the order named

(5) *Pinus resinosa* (red pine), *Larix* spp (Larch), *Picea* spp (Spruce), and *Abies* spp (Fir) show little evidence of serious attack by insect enemies

(6) Quantitative counts reveal the fact that *Adelges pinicorticis* (Fitch) is probably the most widespread pest of white pine in the forest, and attacks trimmed trees more frequently than untrimmed trees in this planting

(7) The pine leaf scale, *Chionaspis pinifoliae* Fitch, is abundant on the lower branches of older trees, and, while not now serious, may become a serious pest in the future

(8) The ecological succession in insect attack of white pine seems to be initiated by *Pityogenes punctipennis* Lec, followed by various borers and bark beetles

(9) A composite table has been prepared showing the pests of the principal coniferous areas of eastern North America.

(10) An examination of this table shows that there are many pests in those areas that are potential enemies of southeastern Ohio trees.

(11) A comparison of the insect fauna in York Forest with that of West Virginia reveals the fact that there is a duplication of coniferous insect pests This suggests that further pests may be expected in this area soon

(12) The present data indicate that future reforestation activities in southeastern Ohio must take into account insect pests as factors of importance.

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The Science of Colors.

This is a translation of the German edition of the treatise on color by the late Dr. Ostwald It is a complete and unified theory of color standards and classification It supplements but differs somewhat from the well-known theories of Helmholtz, von Bezold, Rood, Ladd-Franklin and the rest. The "color circle," a closed ring of saturated chromatic colors, is postulated. A "color solid," based on the application of Fechner's law, is constructed, in which all colors conform to the principle of "psychological equality" as expressed by the equation $C + W + B = 1$, where C = amount of full color, W = amount of white and B = amount of black. These three constants are substituted for the two older entities "purity" and "luminosity." The fact is demonstrated that three pigments are not sufficient for reproducing colors by printing, but that five is the smallest requisite number. The principles of color harmony are fully expounded in the clear and direct style characteristic of the entire book. Colored plates illustrating the standards of hue making up the color circle, a section of the color solid, representative isovalent circles, and the achromatic standards, are included.—L. H. S.

Colour Science, by Wilhelm Ostwald, translated by J. Scott Taylor. Part I, xviii + 141 pp., Part II, xii + 173 pp. London, Winsor and Newton, 1933. (In the United States, Winsor and Newton, Inc., 31 E. 17th St., New York City.)

PROTHETELY IN EPILACHNA CORRUPTA MULS. (COLEOP.)[1]

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Prothetely in larvae of holometabolous insects has been reported for single or few individuals, usually in cases of transfer from the field to the laboratory, where the unusual development became apparent Observers in reporting on these individuals believe the change of environment responsible and list temperature, humidity, and cumulative quantities of carbon dioxide as possible causes

FIG 1 Prepupa of bean beetle showing wing pads

Such abnormal larvae, in which precocious appearance of structures is visible (Fig. 1), have been occasionally observed in laboratory rearings and field collections of the Mexican bean beetle, *Epilachna corrupta* Muls., at Columbus, Ohio, over a period of three years.

Larvae with wing pads have been observed by the writers from three separate localities under field conditions In the summer of 1933 at Columbus they occurred in field collections

[1]The writers are indebted to Dr. N F Howard, Mr G V Johnson, and Mr. P. G. M. West for much of the material.

from June throughout the summer and as late as October 3. Samples of from 200 to 400 larvae taken from a 10-foot unit length of row yielded two prothetelic larvae on two occasions. In August a larva with wing pads was taken at South Point, Ohio, approximately 125 miles southeast of Columbus, and in September a similar individual appeared in a collection from Williamstown, W. Va In February a larva with wing pads was found among larvae reared in a heated laboratory and in early June another was taken from larvae reared in a screened

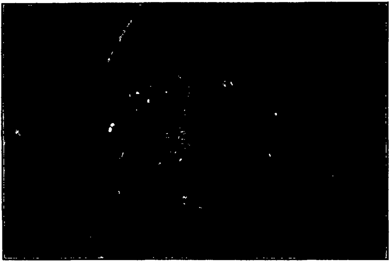

FIG 2 Prothetelic prepupa of bean beetle sloughing the last larval cuticle

outdoor insectary It is estimated that one larva with wing pads had appeared for each 10,000 larvae handled at Columbus during 1932 and 1933. Probably 25 individuals have been observed in all and in September 1933 five larvae with wing pads were at hand at one time.

Wing pads have been observed only in the fourth instar of the bean beetle This instar consists of a motile larval phase and an attached quiescent or prepupal phase. The pads appear as two pairs of soft saclike evaginations of the dorsolateral walls of the mesothoracic and metathoracic segments. These turgid pads are of nearly equal size and shape and terminate in slightly pointed tips The mesothoracic pads are covered with irregular fine brown setae not found on the

metathoracic pair In some individuals collected the anterior pair of pads were dead and appeared as hard black knobs.

Several prothetelic larvae in the late fourth instar were observed sloughing the last larval cuticle prior to pupation (Fig 2) The process was not completed and the individuals died No cases were observed where larvae with wing pads passed successfully into the true pupal stage

The wide seasonal and environmental ranges under which these unusual forms have been observed suggest that something other than environmental factors may be responsible for their appearance

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Geology of Puerto Rico.

The Geology of Puerto Rico is presented in 5 parts plus Conclusions, Bibliography, Glossary, and Index In Part I the "Geologic Background" is presented in which the relation to the neighboring islands is set forth Part II is "Geologic History" in which the actual known geology is depicted from the time of the volcanic core to the present form of the Island. The geologic column shows considerable volcanic rocks of upper Cretaceous age or older Associated with these are shales and calcareous deposits, both often with much tuff The Tertiaries are clastics and limestones of both the reef and shell types The Quaternary is generally unconsolidated recent material Part III entitled "Geologic Materials" is not petrography but a geologic discussion of the rocks, their structures, natural resources and the soils. In Part IV the "Geologic Present" deals with the physiography and the earthquake factors in the Island Part V presents rather clearly the numerous questions to which answers are not known as yet relative to the geology of the region

To briefly sum up the author's conclusions On a shield of very ancient rock there was much volcanic activity with the regions between the volcanoes inundated by the sea Later this volcanic-marine series was folded into mountains with accompanying intrusions of igneous rock This mass was eroded to form the complex core On the margins of this core were formed limestones and clastic deposits as the mass slowly sank Then came a long series of uplifts so that the latter history is one of fluvial planation and uplift, the last uplift developing the rifts which set off the Island so abruptly Now we have erosion working on a still unstable, tilted block

To one interested in the Geology of the region this is a gold-mine of information. It is unfortunate that the author does not include fossil lists which are available. We hope that a latter Monograph will include them, to make the Series complete This omission does not deduct from the value of the work The author has spent enough time in the region to be familiar with the broader aspects of the geology and the details of numerous small areas and has made good use of the literature on the subject Both Dr Meyerhoff and the University of Puerto Rico are to be congratulated and we hope this new series of Monographs will all live up to the first one.—WILLARD BERRY

Geology of Puerto Rico, by H A Meyerhoff 306 pp Univ of Puerto Rico Monograph No 1, series B 1933

DEVELOPMENT AND DIFFERENTIATION OF TISSUES IN THE STEM TIPS OF GRASSES.

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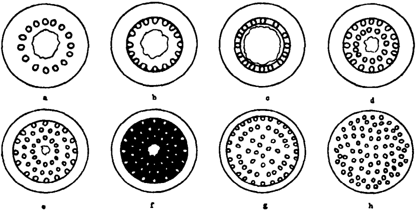
INTRODUCTION.

The study of the anatomy of the vegetative organs of the grasses has been confined to the examination of the mature structures The internal anatomy of the leaves has been studied by Duval-Jouve (10), Pee-Laby (15), Lewton-Brain (16), Schwendener (19), Arber (2), Guntz (12), Holm (13), and others with special reference to differences that show means of identification of species, and with reference also to the types of structure in relation to the various habitats (14, 16, 18, 24). The work on the stem structure of the Gramineae is confined mainly to a record of the occurence of amphivasal bundles and to the theory of cambial activity in relation to the phylogeny of the group as stated by Van Teighem (23), Guillard (11), Crysler (8), and Holm (13).

The grasses have been described as hollow stemmed plants with scattered vascular bundles; and neither statement is definitive Many of the grasses have solid stems, especially when grown in xerophytic situations; many of them do not have scattered vascular bundles, but have the bundles (Text Fig 1, a, b, c) arranged in a circle between a central pith and an outer cortex (22). Many of the Festuceae and the Hordeae (Text Fig 1, b) have a single circle of vascular bundles, while in the Agrostideae and Paniceae there are from one to three cycles of bundles (Text Fig 1, d, e, f) in addition to the set in contact with the pericycle Some of the Paniceae and all of the Andropogoneae have three or four cycles if vascular bundles (Text Fig 1, e, f, g) in addition to those in contact with the pericycle, and the Tripsaceae (or Maydeae) have the vascular bundles in the scattered arrangement (Text Fig 1, h). Some of the genera of the tribes present exceptions, but the general tendency is from vascular bundles in one circle to the arrangement scattered throughout the pith.

Most of the hollow stemmed grasses are those with only one or two cycles of vascular bundles around a large pith, and

most of the solid stemmed species are those with the scattered bundles or those with three or more cycles and a small pith. The first group is solid stemmed only when in slow-growing situations; the corn type is solid stemmed in any situation, and the Paniceae type of small pith is solid in xerophytic habitats. Canfield (6) reports that in the Jornada region of the southwest the hollow stemmed grasses are those that grow in more favored situations as to water supply and most of those that he reports as solid are members of the tribes that

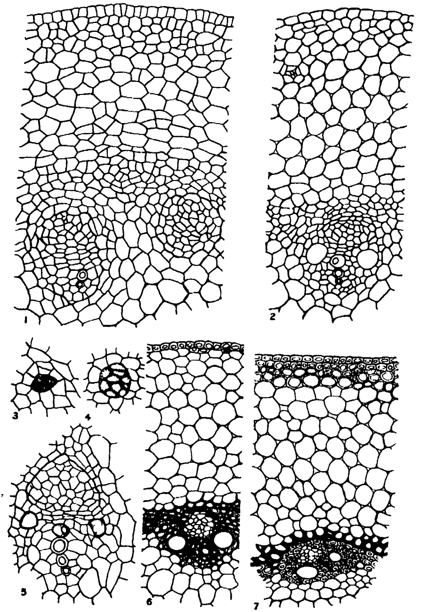


Text Fig. 1 Diagrammatic cross-sections of grass stems showing the arrangement of the vascular bundles of the stele a, Leerzia, b, Agropyron, c, Phragmites; d, Eragrostis and Phleum; e, Aristida and Setaria, f, Panicum, g, Andropogon; h, Zea

have the several cycles of bundles and small pith or those without pith and with scattered vascular bundles

Duval-Jouve (10) states that the presence of a cortex and stele is the only thing about the stems that is common to all grasses. In the more primitive grasses the cortex is much thicker in proportion to the diameter of the stele than in the higher forms The presence of a definite stelar pericycle in most of the tribes marks the limit of the stele and cortex, while in such genera as Sorghum and Zea the lack of a thickened pericycle fails to delimit these areas in the mature stem The stem tips of Zea, however, do show a cortex

This paper presents a study of the development and differentiation of tissues in four species of grasses whose mature structures show marked differences in the arrangement of the vascular strands Serial sections through several nodes of the



FIGS. 1 TO 7, *Agropyron repens* (L.) Beauv.

stem tip were studied, and the arrangement and differentiation of vascular bundles of these were compared with the internodes of the mature stem, sectioned just below the node in the region where greatest lignification occurs, and also just above the node where the cells retain their meristematic activity longer. Sections of the rhizome and aerial stems of short and elongated internodes have been examined and found to show interesting relationships in structure, especially as to the character of the vascular bundles and the stelar and bundle pericycle

The arrangement of vascular strands in grasses is of various types (22), but those chosen for this study are (a) vascular bundles in a single circle as shown by *Agropyron*, (b) vascular bundles in two to five circles as in *Spartina* and *Calamovilfa*, and (c) vascular bundles scattered as in *Zea* The first two always have a central pith although they may be hollow in maturity This arrangement of bundles in a single circle has been shown by Holm (13) and by Duval-Jouve (10) The variations from the arrangement of bundles seen in *Agropyron* to the extreme scattered type in *Zea* seem to show a definite trend of vascular evolution with the scattered bundles as the highest type in the series

Description

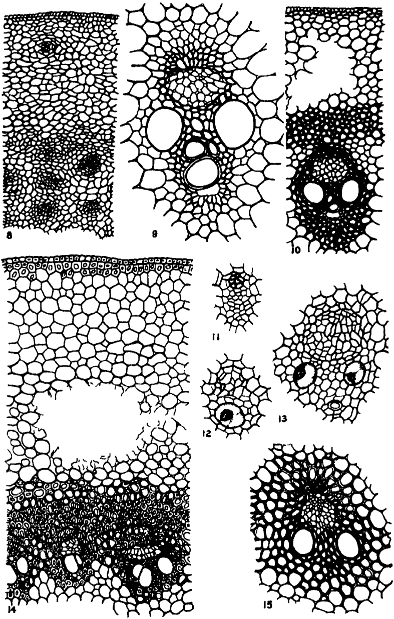
Agropyron repens (L.) Beauv

(Plate I)

The vascular strands of this grass arise in the stem tip in a circle that marks off a definite cortex and pith (Figs 1, 2) No vascular strands are formed in the pith and those found in the cortex are leaf traces. Thus the arrangement in the meristem is the same as in the mature stem The form of the mature bundle, however, varies as to the number of protoxylem vessels according to the degree of elongation (Figs 5, 6, 7) The youngest bundle strand is recognized by the denser cytoplasm of two or three cells (Fig 3). These rapidly divide until a cross section of the bundle shows from 25 to 30 cells (Fig. 1) This is

EXPLANATION OF PLATE I

Fig 1 Cross-section of young stem tip showing two young bundles of the circle
Fig 2. Older stage of the same stem tip
Figs 3 and 4 Cross-section of young bundles
Fig 5 Bundle from rapidly growing region showing cambium-like cells caused by pressure of xylem and phloem
Fig 6 Portion of rhizome of longer internode near surface of ground showing two protoxylem vessels and lignified endodermis and pericycle
Fig 7. Portion of rhizome showing heavy endodermis and vascular bundle without protoxylem. Epidermis and hypodermis are thick-walled and lignified



FIGS 8 TO 15, *Spartina michauxiana* Hitchc

followed by a general enlargement and division of the whole strand until the first protoxylem vessels are formed (Fig 1), and then the cells of the phloem region continue to divide and enlarge so that they appear as a definite area of the bundle (Fig. 1). In the slow-growing internode only one or two small protoxylem vessels are formed, sometimes none at all (Figs. 6, 7), for example, in the rhizome the phloem is differentiated first and only one to three metaxylem vessels are formed (Fig. 7). In the aerial stem of long internodes from two to five protoxylem vessels are developed (Figs. 5, 6).

In the rhizome there is a pronounced endodermis and a pericycle (Fig. 7) which is of thick-walled lignified cells and almost surrounds the vascular strands that in turn become wholly lignified except for the phloem (Fig. 7). The cortex develops small air passages, and the epidermis and hypodermal layers become lignified. In this same stem the pericycle and endodermis gradually diminish as the culm becomes aerial and in some forms entirely disappaer in the above-ground parts

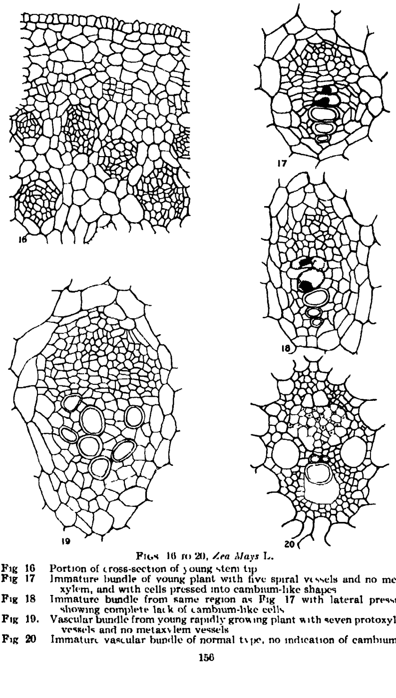
Spartina michauxiana Hitchc

(Plate II)

In *Spartina* the vascular strands arise in a band of two or three circles with a definite cortex (Fig 8). The bundles first appear as they do in the other forms, but the metaxylem vessels are the first water tubes to appear (Fig. 12). The sieve tubes and their companion cells form at approximately the same time Similarly in the rhizome and slow-growing internodes of the aerial stem no protoxylem vessels are found, but in the elongated internodes of the aerial part there may be two or more (Figs. 9, 10). In the rhizome the outer circle of vascular bundles is imbedded in the lignified pericycle which is surrounded by an endodermis (Fig 14). The inner circles are not connected to the pericycle except for an occasional bundle. This structure is in contrast to the aerial stem of *Spartina* where the endodermis and pericycle appear only in fragments In both rhizome and aerial stems the epidermis and hypodermal layers become thick-walled and lignified, and in both the cortex enlarges and there appear numerous lysigenous air passages (Fig. 14)

EXPLANATION OF PLATE II

Fig 8 Portion of young stem tip showing young vascular bundles and cortex
Fig. 9 Inner vascular bundle of the aerial stem
Fig 10 Portion of aerial stem showing cortex with air passages, and one of the outer circle of vascular bundles attached to a fragment of the pericycle
Fig 11 Young bundle showing beginning of phloem before any xylem tubes appear
Fig 12. Young bundle showing phloem with companion cells and a single metaxylem vessel
Fig 13 Cross-section of bundle showing a single spiral vessel which was formed after the metaxylem vessels were enlarged
Fig 14 Portion of cross-section of mature rhizome
Fig 15 A single vascular bundle of a short internode of rhizome without spiral vessels, all of the cells lignified except phloem



FIGS. 16 TO 20, *Zea Mays* L.

Fig. 16. Portion of cross-section of young stem tip.
Fig. 17. Immature bundle of young plant with five spiral vessels and no metaxylem, and with cells pressed into cambium-like shapes.
Fig. 18. Immature bundle from same region as Fig. 17 with lateral pressure showing complete lack of cambium-like cells.
Fig. 19. Vascular bundle from young rapidly growing plant with seven protoxylem vessels and no metaxylem vessels.
Fig. 20. Immature vascular bundle of normal type, no indication of cambium.

Calamovilfa longifolia (Hook.) Hack.

The stem structure of *Calamovilfa* (Text Fig. 1) is similar to that of *Spartina* except that in the mature rhizome all the vascular portion of the stele becomes very thick-walled and even the phloem cells become lignified. The vascular bundle originates from a single cell and develops as in *Agropyron* with protoxylem vessels only in the bundles of the longer internodes. In this highly lignified stem some of the bundles in the nodes and short internodes are amphivasal. In the aerial stem there is evident cortex, and a pith that finally breaks down in the center so that the stem has a small cavity.

Zea Mays.

(Plate III)

In the stem tip of corn the vascular strands develop at some distance from the epidermis and mark off a cortex (Fig. 16). This apparently disappears because there is no development of pericycle and endodermis, and therefore with the abundant leaf traces the mature stems have numerous scattered bundles without a definite marking to show the limits of the stele and cortex.

The vascular strands evidently begin with two or more cells, and the protoxylem vessels are the first cells of the bundle to be differentiated. In the rapidly growing young plants of the laboratory where there is little lignification the number of protoxylem vessels is larger than in any other form examined (Figs 17, 18, 19), and in these bundles no metaxylem vessels are developed This is a variation from normally grown plants where the vascular bundle develops as in *Agropyron* and *Calamovilfa* (Figs 16, 20) As in the other grasses lignification in aerial stems is greatest just below the node In the short internodes the bundles do not have lacunae, although practically all the strands of the average length of internode have lacunae by reason of the destruction of the protoxylem vessels by rapid elongation after their lignification (Fig. 20).

CAMBIAL ACTIVITY.

Crysler (8), Van Teighem (23), Guillard (11), and Anderssohn (1) have reported and figured a temporary cambium in several grasses One does not find in their studies any figure of mitotic phases in these cells; and evidently all the figures were taken from either mature or nearly mature aerial stems, or from the meristematice region of the lower part of the internode The present study has not revealed any cell division in the area between xylem and phloem after these areas are differentiated except for occasional cells Cells divisions do occur in the xylem and phloem areas of the vascular strand and not in the cells between them where the cambium would originate. The number of cells that occur on a line from the

inner portion of the phloem to the innermost cell of the xylem is within one or two cells of being a constant number, regardless of the size of the bundle. Apparently this number does not change after the xylem vessels begin to be lignified. The explanation of the appearance of cambial cells—and this is very striking—is that the rapid enlargement of the phloem and xylem presses the intervening cells into the shape of cambium cells (Figs. 1, 2, 5, 17) In those bundles where the pressure is lateral, although several protoxylem vessels are formed, no semblance of cambium appears (Figs 18, 19).

The meristematic condition of all cells of the vascular bundle in growing regions is evident from the continued differentiation of protoxylem vessels in such bundles (Figs. 17, 18, 19). The appearance of a cambial arrangement of cells in a relatively small number of bundles and its absence in other bundles of the same size in the same meristematic area, (Figs 18, 19), the absence of observed mitosis, and the constancy of number of cells mentioned above, all seem to demonstrate that there is not even a temporary cambium in the grass bundle (Fig 21)

DISCUSSION

If a complete study of the comparative anatomy of the grass tribes is made it now seems possible to the writer that some of the questions regarding the position of the tribes in a developmental series may be solved The scattered vascular bundle type is certainly the top of the series, as it is now placed, and the writer believes that the single circle of bundles between cortex and pith is the lowest form of the series (22). The relationship of genera and their proper places within the tribes may be made clear also by the study of the vascular anatomy The question of species must take into account the effect of environment of stem structures, since the development of tissues shows such definite variations in response to the rates of growth (Figs 5, 6, 7, 10, 14, 18, 19, 20). The cortex, endodermis, and pericycle vary in amount and degree of lignification depending not only on the inherited type of bundle arrangement in the series pointed out but also on the rate of growth. The marked differences in the development of the xylem strands is directly related to the rate of growth, and there seems to be very little variation in the stucturre of the individual bundle phylogenetically except as to the amount and character of the bundle pericycle.

Various authors have figured and labeled a proto-phloem as distinct from the mature phloem. It is evident from the figures shown in this paper that there is no such distinction The xylem and phloem develop by cell divisions in the inner and outer portions of the vascular bundles and there is no further development after their differentiation except the thickening and lignification of the cell walls of the water tubes and bundle pericycle.

SUMMARY

1. All the stem tips of the grasses studied show a stele and a cortex even though they are not delimited in the mature stem

2. The vascular bundles of the grasses are not all arranged as in *Zea*, for the arrangement varies from a single circle through a series of forms to the scattered vascular bundle type

3. The hollow stem or solid stem in the grasses depends first upon the arrangement and number of the vascular bundles and second upon the rate of growth

4. There is a tendency for both the stelar and bundle pericycle to become less pronounced as the scattered vascular bundle type is approached

5 In the vascular bundles·

a The number of the protoxylem vessels varies with the amount of elongation and the duration of the meristematic condition.

b There is no distinction of proto-phloem and meta-phloem.

c There is no temporary cambium.

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Invertebrate Zoology.

This, the most recent of the many zoological textbooks written by the author, is stated to be a revision and expansion of his first, the Introduction to Zoology, published in 1910. It is well planned and organized, and in the same general style as his previous books The classification is, on the whole, conservative Short, but comprehensive descriptions of representative types are given, in which both structural and functional aspects are stressed Illustrations are numerous, and for the most part clear and well selected, although there are a few serious omissions and some poor selections The only strictly original illustrations are the eight excellent full-page stereograms by Mrs Root.

Careful examination and several months' use as a textbook in the reviewer's classes have disclosed a number of defects Typographical errors are far too frequent for a book of this character Drawings borrowed from other authors have usually been redrawn and relabeled, and while the redrawing has been good, the relabeling has in several cases been careless and confused. (For example, figures 71, 252, 254, 256) The life history of Gonionemus is not given as fully as it might have been, the author does not seem to be familiar with Joseph's 1925 paper on this subject In the chapter on Mollusca there is no discussion of the lamellibranch gill as a feeding mechanism, and no adequate description of its structure or its ciliation.

Similar omissions may be noted in other chapters also The discussions of the comparative anatomy and phylogeny of the invertebrates seem inadequate for an advanced textbook of invertebrate zoology —W J KOSTIR.

Invertebrate Zoology, by Robert W Hegner. xiii + 570 pp. New York, The Macmillan Co., 1933.

A NEW SPECIES OF TYPHLOCYBA (HOMOPTERA CICADELLIDAE) INJURIOUS TO PRUNE IN THE PACIFIC NORTHWEST.

D M DeLONG AND RALPH H. DAVIDSON,
Ohio State University, Columbus, Ohio.

Typhlocyba pruni n. sp.

Resembling *T. pomaria* McA. in form and general appearance and apparently previously confused with it. But with a brighter yellow appearance, head more bluntly and broadly rounded and male genital character distinct. Length 7 mm

Vertex bluntly broadly rounded, strongly curved in front.

Color: Male, pale yellow, wings bright yellow for two-thirds their length, apical third smoky; female, milky white usually without yellow markings.

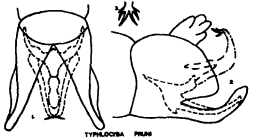

FIG 1 Ventral view of male genitalia in position
FIG. 2 Lateral view of male genitalia in position.
FIG 3 Dorsal view of apex of oedagus (enlarged), showing arrangement of spines.

Genitalia: Female, last ventral segment roundingly produced, male, valve short, broad, transverse, slightly emarginate at middle. Plates broad at base, abruptly narrowed at about one-third their length and produced in rather long narrow tips which are upturned and slightly divergent Styles long and narrow. Apices turned inward and sharp pointed, the long tips overlapping when in natural position. Oedagus directed upward and anteriorly at the apex, the apical portion composed of two branched and two unbranched spines. The inner two are unbranched and are longer than the outer two which are branched. From the dorsal view the two inner

spines are divergent toward the tip while the dorsal portion of the outer spines curve slightly inwardly From the lateral view the lower fork of the outer spine can be seen projecting ventrally

Described from a series of specimens collected at Parma, Idaho, and Opportunity, Washington The senior author collected specimens at Parma in the summer of 1930, while collecting in the field with Mr Haegele and a large series has been recently forwarded from both localities by Mr. R. W Haegele of the Parma Station. These were collected in July and September and were all taken from cultivated prune

Holotype male and allotype female from Parma, Idaho.

The Theory of Embryological Development.

Part I is a translation and condensation of **Theoretische Biologie,** 1932, while Part II, the major part of the work, is a translation of "Kritische Theorie der Formbildung," 1928 In Part I, von Bertalanffy points out that the present method of biological thought is not on the high plane of that in physics, mathematics, and astronomy, where theory after theory is boldly proposed to be superseded by one better when the preceding can be shown to be inapplicable He believes that leaders in biology do not theorize enough In a way von Bertalanffy is right Baffled by the complexity of problems the average biologist hesitates to formulate theories Unfortunately in many minds this attitude has become almost a doctrine which creates a depressing atmosphere in which to work

Part II is a review and searching critique of the recently proposed explanations of embryological development and regeneration The mechanistic theories are shown to be weak because they explain development as an arithmetical increase in complexity, an additive process The vitalistic theories fail because they include a transcendent entelechy, an immaterial principle that cannot be demonstrated "Neither of these views is justified by the facts The solution is to be sought in an **organismic** or **system** theory of the organism which, on the one hand, in opposition to the machine theory, sees the essence of the organism in the harmony and co-ordination of the processes among one another, but, on the other hand, does not interpret this co-ordination as vitalism does, but through the forces imminent in the living system itself " The theory will have to consider the developing organism, (1) as a physico-chemical system, (2) in its intricate organization, and (3) as an end product of its evolutional history

The author admits the difficulty of outlining such a master theory, but points out some features that will have to be included It must (1) be a law of biological maintenance, "the organic system tends to preserve itself " It exists as a pseudo-equilibrium (Przebram's bio-dynamic equilibrium) as it is capable of doing work (2) The organization indicates an heirarchial order of parts and forces (Child's metabolic gradients) From this there is a tendency towards maximal organization Among the organizing forces are the "field laws" of Weiss and the geometrical conceptions of Gurwitsch

The only criticism beyond that of the involved German style is that half of the animal species are recessive in evolution and to some extent recessive in later stages of ontogeny These are the parasites and others that settle down to a food supply continuous in space in consequence of which they become less complex in their loss of locomotor organs and sense organs The ontogeny of the tunicates is a good example —C H K.

Modern Theories of Development; An Introduction to Theoretical Biology, by Ludwig von Bertalanffy (Translated and adapted by J. H. Woodger) Pages i-x and 1-204 New York, Oxford University Press, 1934 $3.00

ADDITIONS TO THE OHIO LIST OF ROBBER FLIES II (DIPTERA ASILIDAE)

STANLEY W BROMLEY.

There were 65 species of Asilidae recorded from Ohio in my "Preliminary List of the Robber Flies of Ohio" (Ohio State Museum Science Bulletin, Vol I, No 2, November 1, 1931). During the season of 1932 and 1931, five species were added, bringing the total to 70 (Ohio Journal of Science, Vol. XXXIII, No 3, May, 1933, p 204) During the summer of 1933, Mr. E S. Thomas, Curator of Natural History of the Ohio State Museum, and Mr Charles F. Walker, Assistant Curator, continued their active collecting, with the result that the Ohio Asilid material in the Museum of four years ago has been increased about five-fold Some very interesting records have been obtained Among them were two additional records for the state

71 *Atmosia rufipes* Macquart. McArthur, Ohio, July 11, 1933 (E. S Thomas)

72 *Asilus puceus* Hine Holland, Lucas County, August 11–13, 1933 (E S. Thomas) A rare species hitherto recorded only from New England

Other records of interest were two specimens of *Lampria bicolor* (Wiedemann) taken by E S Thomas at "Neotoma," Hocking County, July 3–4, 1933, two specimens of *Leptogaster brevicornis* Loew taken at the same locality, July 3–9, 1933; a series of six *Proctacanthus milbertii* Macquart, Holland, Lucas County, August 11–13, 1933 (L W Campbell, R. Conant, and E. S Thomas), and a specimen of *Promachus hinei* Bromley taken in Salem, Champaign County, July 27, 1933, by Charles F Walker

Most interesting of all was the capture by Mr Charles F. Walker at the State Game Farm, Salem, Champaign County, of two specimens of the extremely rare *Dasylechia atrox* Williston; one on August 2, and one on August 29, 1933 I am quoting Mr. Walker's observations on this remarkable insect. "In both instances, the flies first attracted attention by their loud droning flight as they circled about my head. In one

case, we were working around a new wooden shed, and my first thought was that the insect was a carpenter bee attracted by this fresh wood Their appearance was very suggestive indeed of these bees until they came to rest, in one case on an electric line; in the other, on a chicken-wire cover to a partridge pen They were unsuspicuous and sluggish, in one case easily allowing capture by hand, and the other—the one on the electric wire out of reach—was easily secured with a net. The location was an open pastured oak-hickory-maple woodland on a gravelly moraine." Both were males. This makes the fourth Ohio record of this species (all from the Western part of the state). There are scarcely more than a dozen records of this species

This calls to mind an account of the capture of one of these rare flies, related to me by the late C W Johnson, Curator of Insects of the Boston Society of Natural History. In this case, the fly persistently flew about the head of a pedestrian in a city park of Philadelphia, Pa., until it was captured

Mr. H. J. Reinhard, Entomologist of the Texas Agricultural Experiment Station, during July collected extensively at Amherst, Lorain Co, Ohio, securing among a large series of Leptogasters, two species hitherto unrecorded from the state. These additions bring the Ohio Asilid list to 74 species.

73. *Leptogaster atridorsalis* Back. Amherst, July, 1933 (H. J. Reinhard).

74 *Leptogaster (Psilonyx) annulatus* Say. Amherst, July, 1933 (H. J. Reinhard)

Historical Geology.

This text departs from the time honored system of period by period discussion of Geologic history It is divided into two major parts, the first 80 pages taking up the "Principles of Stratigraphy" and the remainder of the book concerning "Geologic Provinces" Under the caption "Geologic Provinces" are considered the following localities. the Grand Canyon Region, Niagara Falls, the Appalachians, the Northwest Highlands of Scotland, the Alps, and Yellowstone Park and the Big Horn Basin Region. The plates are either uncolored geologic maps or block diagrams of the regions discussed. The figures which are line cuts include numerous small maps illustrating various stages in the geologic history of the regions concerned. The reviewer is not as yet prepared to say whether he is in favor of this new manner of presentation of Historical Geology, although he admits that the old manner of presentation is far from perfect The question arises, is it preferred to give the student the complete history of a Continent or is it better to explain the local history of selected parts? Certainly from the latter standpoint this text is excellent We would be inclined to say that it is the type of text for the passing student and not so much for the student who is mainly interested in advanced Geology.—WILLARD BERRY.

The Principles of Historical Geology from the Regional Point of View, by Richard M. Field. xii+284 pp. Princeton, the University Press, 1933.

ADDITIONS TO THE REVISED CATALOG OF OHIO VASCULAR PLANTS. II*

JOHN H. SCHAFFNER.

There appears to be no abatement of the interest in the Ohio flora, aroused by the publication of the Revised Catalog in 1932, as is evident from the list of additions presented below This list represents but a small percent of the records showing decided extensions of the geographic ranges of our Ohio species. In the first list of Additions to the Catalog, 41 species new to the state were published; in the present list, 34 new Ohio species are added, bringing the total number of species cataloged for Ohio up to 2,384 Among the many interesting discoveries are several species originally published by Bigelow, in 1841, as occurring in Fairfield County but not known to have been seen since that time. A report on the status of some of the Ohio species of Phlox by Edgar T. Wherry of Philadelphia, a specialist in this difficult group, is included in its proper place below, and it is hoped that collectors will make special efforts to send in specimens of the rarer species that we may soon have a more reliable list During the year about 4,000 specimens have been mounted, labeled, and distributed in the State Herbarium The Herbarium is still greatly hampered by a lack of suitable cases to hold this valuable collection properly, and it is hoped that this difficulty may be overcome in due time, when more favorable financial conditions return Ohio is certainly rich enough to develop one good herbarium There should be a number of such institutions in the state

1 *Ophioglossum vulgatum* L Adder-tongue Indian Springs ravine, Columbus, Franklin Co Mrs M S Humphrey.

2 *Botrychium simplex* Hitch Little Grape-fern Farnham, Ashtabula Co. L E Hicks

3 *Botrychium neglectum* Wood Wood's Grape-fern Indian Springs ravine, Columbus, Franklin Co L E Hicks

10 *Pellaea glabella* Mett Northern Purple Cliff-brake "On perpendicular face of slightly shaded low limestone cliffs" North-west of Locust Grove, Adams Co Arthur N Leeds

41. *Dryopteris dilatata* (Hoffm) Gr Spreading Shield-fern. Near Beach City, Sugar Creek Twp , Stark Co W H Camp.

53 *Equisetum laevigatum* A Br Smooth Scouring-rush Mentor Marsh, Lake Co L E. Hicks

*Papers from the Department of Botany, the Ohio State University, No 338.

55 *Equisetum kansanum* Schaffn Kansas Scouring-rush. Conneaut R. Ashtabula Co L E Hicks

66 1 *Lycopodium tristachyum* Pursh Slender Trailing Club-moss Liberty Twp, Jackson Co Floyd Bartley and Leslie L Pontius Also old misnamed specimens from Licking (R F Griggs), Fairfield (E V. Wilcox), and Hocking (R F Griggs) counties

67 *Lycopodium complanatum* L Trailing Clubmoss The var flabelliforme Fern Near Beach City, Sugar Creek Twp, Stark Co W H Camp

69 *Selaginella apoda* (L) Fern Creeping Selaginella Serpent Mound, Adams Co Edw S Thomas

78 *Juniperus communis* L Common Juniper Parkman Twp, Geauga Co Charles Dambrach

78a *Juniperus communis depressa* Pursh. Parkman, Geauga Co L E Hicks, C Dambach, and F B Chapman

90 *Scheuchzeria palustris* L Scheuchzeria Lake Twp, Ashland Co Leslie L Pontius and Floyd Bartley

101 *Potamogeton perfoliatus* L Clasping-leaf Pondweed Tuscarawas River, Fayette Twp, Coshocton Co Frank B Selby, Ashtabula Beach, Ashtabula Co L E Hicks

108 *Potamogeton dimorphus* Raf Spiral Pondweed Liberty Twp, Jackson Co Leslie L Pontius and Floyd Bartley

111 1 *Naias marina* L Large Naias Lake Cardinal, Ashtabula Co L E Hicks

114 *Brasenia schreberi* Gmel Water-shield Mouth of Conneaut River, Ashtabula Co L E Hicks

114 1 *Cabomba caroliniana* Gr Cabomba Abundant in Mosquito Creek. Escaped From the South Howland Twp, Trumbull Co Almon N Rood

115 *Nelumbo lutea* (Willd) Pers. American Water-lotus Jerusalem Twp, Lucas Co Louis W Campbell

117 *Castalia odorata* (Dry) W & W Sweet-scented Water-lily Jerusalem Twp, Lucas Co Louis W Campbell

118 *Castalia tuberosa* (Paine) Greene Tuberous Water-lily Silver Lake, Logan Co E Jane Spence Sent in by Wm C Werner Mouth of Conneaut River, Ashtabula Co L E Hicks

150 *Scirpus planifolius* Muhl Flat-leaf Clubrush Toledo, Lucas Co J A Sanford (1878) Presented by Wm C Werner

155 *Hemicarpha micrantha* (Vahl) Pax Common Hemicarpha Geneva, Ashtabula Co L E Hicks

157 *Eleocharis acuminata* (Muhl) Nees Flat-stemmed Spike-rush. Swamp near Chillicothe, Ross Co F B Chapman

160 1 *Eleocharis rostellata* Torr Beaked Spike-rush Cedar Swamp, Champaign Co Edw S Thomas

166 *Stenophyllus capillaris* (L) Britt Hair-like Stenophyllus. Liberty Twp, Jackson Co Leslie L Pontius and Floyd Bartley

169 *Cyperus retrofractus* (L) Torr Rough Cyperus Liberty Twp, Jackson Co Floyd Bartley and Leslie L. Pontius.

173 *Cyperus engelmanni* Steud Engelmann's Cyperus E. Conneaut Beach, Ashtabula Co L E Hicks.

177 1. *Cyperus acuminatus* Torr & Hook Short-pointed Cyperus Green Twp, Ross Co Floyd Bartley and Leslie L Pontius.

187 *Mariscus mariscoides* (Muhl) Ktz Twig-rush Cedar Swamp, Champaign Co E S Thomas

189 *Scleria triglomerata* Mx Tall Nut-rush Northwest of Amboy, Ashtabula Co L E Hicks

199 *Carex muhlenbergii* Schk. Muhlenberg's Sedge. Painesville, Lake Co. Wm C Werner Wood Co Albert Neifer

202 *Carex leavenworthii* Dew. Leavenworth's Sedge. Phelps Creek, Ashtabula Co L E Hicks

209 *Carex annectens* Bickn. Yellow Fox Sedge Red Hills region, Franklin Co Floyd B Chapman

212 *Carex prairea* Dew Prairie Sedge Painesville, Lake Co. Wm. C. Werner

216 *Carex crus-corvi* Shuttlw Raven-foot Sedge Wood Co Albert Neifer. Sent in by Wm C Werner
231 *Carex muskingumensis* Schw. Muskingum Sedge Lower Grand River and Rock Creek, Ashtabula Co L E Hicks
233 *Carex straminea* Willd Straw Sedge Conneaut, Ashtabula Co L E. Hicks
261 *Carex eburnea* Boott. Bristle-leaf Sedge Paint Twp, Highland Co Katie M Roads
274 *Carex striatula* Mx Striate Sedge Scioto Co Floyd Bartley and Leslie L Pontius
280 *Carex conoidea* Schk Field Sedge Crystal Lake near New Carlisle, Clark Co E N Transeau
292 *Carex caroliniana* Schw Carolina Sedge Phelps Creek, Ashtabula Co L E Hicks
304. *Carex irregularis* Schw Green Sedge Marl bog at Kennard, Champain Co Edw S Thomas
305 *Carex cryptolepis* Mack Small Yellow Sedge Plymouth Marshes, Ashtabula Co L E Hicks
332 *Bromus inermis* Leyss Hungarian Brome-grass Saybrook, Ashtabula Co L E Hicks Near State Game Farm, Champaign Co E S. Thomas
339 *Festuca shortii* Kunth Short's Fescue grass Conneaut, Ashtabula Co L E Hicks
351. *Panicularia grandis* (Wats) Nash Tall Manna-grass Conneaut, Ashtabula Co L E Hicks
357 *Poa debilis* Torr Weak Spear-grass Wayne Twp, Ashtabula Co L E Hicks
390 *Deschampsia caespitosa* (L) Beauv Tufted Hair-grass Geneva-on-the-Lake marsh, Ashtabula Co L E Hicks
391 *Deschampsia flexuosa* (L) Trin Wavy Hair-grass Mt Pleasant, Lancaster, Fairfield Co R B Gordon Stows Corner Summit Co Floyd Bartley and Leslie L Pontius
409 1 *Cinna latifolia* (Trev) Griseb Broad-leaf Wood Reed-grass Monroe Twp, Ashtabula Co L E Hicks
415 1 *Muhlenbergia capillaris* (Lam) Trin Long-awned Muhlenbergia Liberty Twp, Jackson Co Leslie L Pontius and Floyd Bartley
430 *Aristida purpurascens* Poir Purplish Tripple-awned-grass Liberty Twp, Jackson Co Floyd Bartley and Leslie L Pontius
433a *Phalaris arundinacea picta* L Garden Ribbon-grass Along railway track near New Vienna, Clinton Co Along the road, Piketon, Pike Co Katie M Roads
438 *Lolium multiflorum* Lam Awned Darnel Near Buchtel, Athens Co, Circleville, Pickaway Co Leslie L Pontius and Floyd Bartley
445 *Elymus hirsutiglumis* Scribn Strict Wild-rye Beach near Geneva-on-the-Lake, Ashtabula Co L E Hicks
446 1 *Elymus brachystachys* Scribn & Ball Short-spiked Wild-rye Southeastern Wayne Twp, Ashtabula Co L E Hicks
456 1. *Dactyloctenium aegyptium* (L) Willd. Egyptian-grass, Ashtabula Harbor, Ashtabula Co L E Hicks
491 *Panicum villosissimum* Nash Villous Panic-grass Conneaut, Ashtabula Co L E Hicks
493 *Panicum meridionale* Ashe Matting Panic-grass Crystal Lake near New Carlisle, Clark Co E N Transeau
505 1 *Echinochloa colona* (L) Link Jungle-rice Persistent and spontaneous after cultivation From the South Dorset, Ashtabula Co L E Hicks
508 *Paspalum setaceum* Mx Slender Paspalum Pickaway Twp, Pickaway Co, Liberty Twp, Jackson Co Leslie L Pontius and Floyd Bartley
514 1 *Holcus sudanensis* Bailey Sudan-grass Escaped from cultivation Native of Africa Painesville, Lake Co Wm C Werner
517 *Miscanthus sinensis* Andress Chinese Plume-grass Sunfish Creek, Pike Co M B Trautman
543 *Scilla sibirica* Andr Siberian Squill Along the road in Liberty Twp, Highland Co Katie M Roads

547 *Aletris farinosa* L. Colic-root. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L Pontius
549. *Veratrum viride* Ait American False-hellebore. Perry Twp, Tuscarawas Co Irma Nelson
575 *Clintonia umbellulata* (Mx) Torr White Clintonia White's Gulch, Liberty Twp, Jackson Co. Leslie L. Pontius and Floyd Bartley
596 *Juncus dudleyi* Wieg Dudley's Rush. Crystal Lake, near New Carlisle, Clark Co E N Transeau
611 *Juncoides carolinae* (Wats) Ktz Hairy Wood-rush. Phelps Creek, Ashtabula Co L. E Hicks, F B Chapman, and C Dambach
613 *Juncoides bulbosum* (Wood) Small Bulb-bearing wood-rush In a damp woods near Henley, Scioto Co Katie M. Roads
624 1 *Sisyrinchium strictum* Bickn Strict Blue-eyed-grass In wet field. Higby Prairie, Franklin Twp, Ross Co F. B Chapman and L E. Hicks.
629 *Iris foliosa* Mack & Bush Leafy Blue-flag. Green Twp, Ross Co. Floyd Bartley and Leslie L. Pontius
632 1 *Iris verna* L. Spring Dwarf Iris Nile Twp, Scioto Co Conrad Roth Brush Creek Twp, Scioto Co. A E Waller, Geo. Schoedinger, and Robert McCormick
636 *Cypripedium candidum* Willd White Lady's-slipper Reported as growing in a damp swamp in Portage Co by Almon N Rood
657 *Ibidium praecox* (Walt) House Grass-leaf Lady's-tresses. Fredericktown, Columbiana Co E S Thomas
659 *Ibidium beckii* (Lindl) House Little Lady's-tresses Mouth of Moxahala Creek, Muskingum Co E S Thomas
659 1 *Ophrys cordata* L Heart-leaf Twayblade E Monroe Twp, Ashtabula Co Lawrence E Hicks, and Floyd B Chapman
662 *Arethusa bulbosa* L Arethusa Reported as occurring in a swamp in Portage Co by Almon N Rood
669 *Tipularia unifolia* (Muhl) B S P Crane-fly Orchis. "Neotoma," Goodhope Twp, Hocking Co Edw S Thomas Benton Twp, Hocking Co and Liberty Twp, Jackson Co Leslie L Pontius and Floyd Bartley
692 *Ranunculus arvensis* L Corn Crowfoot. Painesville, Lake Co Wm C Werner
698 *Batrachium circinatum* (Sibth) Rchb Circinate White Water-crowfoot. Wayne Twp, Pickaway Co Floyd Bartley and Leslie L Pontius. Southern Madison Co E N Transeau
727 *Thalictrum revolutum* DC Waxy Meadow-rue Sugar Grove, Fairfield Co Wm C Werner
741 *Sarracenia purpurea* L Pitcher-plant Near Beach City, Sugar Creek Twp, Stark Co, W H Camp
742 *Drosera intermedia* Hayne Spatulate Sundew Copley Swamp, near Akron, Summit Co Specimen in Herbarium of Lake Erie College, Painesville, Ohio Reported by Wm C Werner
746 *Papaver dubium* L Corn Poppy. Wakefield, Pike Co "Abundantly escaped" Conrad Roth
758 *Capnoides aureum* (Willd) Ktz Golden Corydalis Little Mountain, Lake Co Wm C Werner
760 *Fumaria officinalis* L Common Fumitory Painesville, Lake Co Wm C Werner
762 *Berteroa incana* (L) DC Hoary Berteroa Burton Twp, Geauga Co Charles Dambach
765 *Draba verna* L Vernal Whitlow-grass Painesville, Lake Co Wm C Werner
767 *Draba caroliniana* Walt Carolina Whitlow-grass Green Twp, Ross Co Floyd Bartley and Leslie L Pontius.
780 *Lepidium draba* L Hoary Peppergrass Sheffield, Ashtabula Co L. E. Hicks
781 *Lepidium perfoliatum* L Perfoliate Peppergrass Weed in cultivated field Perry, Lake Co Fred J Tyler
789 *Alliaria alliaria* (L) Britt Garlic-mustard Sycamore Twp, Wyandot Co C W Horton, Kingsville, Ashtabula Co L E Hicks

794 *Cheirinia repanda* (L.) Link Repand Cheirinia Geneva, Ashtabula Co L. E. Hicks.

798. *Norta irio* (L.) Britt Longleaf Hedge-Mustard Perry, Lake Co Fred J Tyler Buena Vista, Scioto Co and Ashtabula Co L E Hicks

803. *Barbarea stricta* Andrz Erect Winter-cress Linton Twp, Coshocton Co. Frank B. Selby Burton Twp Bog, Geuaga Co L E Hicks, C. Dambach, and F B Chapman Westerville, Franklin Co L E. Hicks.

814 *Arabis drummondii* Gr Drummond's Rock-cress Ohio State Univ grounds (1893), Columbus, Franklin Co Wm C Werner Fayette and Tuscarawas Twp, Coshocton Co Frank B Selby

837 *Brassica napus* L. Rape Circleville Twp, Pickaway Co, Ross Co, Jackson Co, Floyd Bartley and Leslie L Pontius

839 *Diplolaxis tenuifolia* (L.) DC Wall Rocket Saybrook, Ashtabula Co L E Hicks

840 *Raphanus raphanistrum* L Wild Radish Richmond Center, Ashtabula Co L E. Hicks and F B Chapman

851 *Geranium dissectum* L Cut-leaf Crane's-bill Painesville, Lake Co Otto Hacker Sent in by Wm C Werner

855 *Erodium cicutarium* (L.) L'Her Stork's-bill West Union, Adams Co Conrad Roth

862. *Oxalis acetosella* L White Wood-sorrel Pymatuming Swamp, Ashtabula Co Collected in 1892 Wm C Werner

871 *Tribulus terrestris* L. Land Caltrop Holland, Lucas Co. Laura Rasmussen

880 *Polygala polygama* Walt Racemed Milkwort Painesville, Lake Co Wm C Werner

887 *Phyllanthus caroliniensis* Walt Carolina Phyllanthus Serpent Mound, Adams Co and Springfield Twp, Ross Co Leslie L Pontius and Floyd Bartley

890 *Acalypha ostryaefolia* Raf Hornbeam Three-seeded Mercury. Trenton, Butler Co O D Diller

919 *Malva alcea* L European Mallow Painesville, Lake Co Wm C Werner

929 *Hibiscus oculiroseus* Britt Crimson-eye Rose-mallow Pedro, Lawrence Co Leslie L Pontius and Floyd Bartley

951 *Ascyrum hypericoides* L St Andrew's-cross In woods bordering Peach Mountain, Adams Co Katie M Roads

953 *Crocanthemum canadense* (L.) Britt Canada Frostweed Turkey Foot Lake, Summit Co L E Hicks, and F B Chapman

971 1 *Viola arvensis* Murr Field Pansy From Europe "A bad weed" Burton Twp, Geauga Co L E Hicks and C Dambach

982 *Viola hirsutula* Brain Southern Wood Violet Mouth of Moxahala Creek, Muskingum Co E S Thomas

989 *Viola pedata* L Birdfoot Violet Became established from plantings in a woodland before 1870, near Painesville, Lake Co Specimen, collected by Alice Griswold in May 1884, sent in by Wm C Werner

1002 *Alsine pubera* (Mx) Britt Great Chickweed Rocky wooded hillside Franklin Twp, Coshocton Co Frank B Selby

1011 *Spergula arvensis* L Corn Spurry Sylvania, Lucas Co Leona Kalp Wood

1011 1 *Spergula sativa* Boenn Spurry Liberty Twp, Jackson Co Adventive from Europe Leslie L Pontius and Floyd Bartley

1022 *Silene dichotoma* Ehrh Forked Catchfly Wayne Twp, Ashtabula Co, Burton Twp, Geauga Co L E Hicks, F B Chapman, and C Dambach

1028. *Silene wherryi* Small Wherry's Catchfly Franklin Twp, Adams Co Edw S Thomas

1103 *Pleuropterus zuccarinii* Small Japanese Knotweed Scioto Twp., Ross Co Leslie L Pontius and Floyd Bartley

1124. *Polygonum buxiforme* Small Shore Knotweed Tuscarawas Twp, Coshocton Co Frank B Selby Coleraim Twp, Ross Co Floyd Bartley and Leslie L Pontius.

1125. *Polygonum tenue* Mx Slender Knotweed Liberty Twp, Jackson Co. Floyd Bartley and Leslie L Pontius

1133 *Dasiphora fruticosa* (L) Rydb Shrubby Cinquefoil Bern Twp, Fairfield Co. E S Thomas, C F Walker and Robt Goslin

1134 *Potentilla paradoxa* Nutt Bushy Cinquefoil Cedar Point, Erie Co In Deam Herb, Bluffton, Ind Chas C Deam

1142 *Comarum palustre* L Purple Marshlocks In County Line Bog West Liberty, Champaign Co L E Hicks and E S Thomas

1151 *Rubus strigosus* Mx Wild Red Raspberry Oak openings Spencer Twp, Lucas Co Louis W Campbell

1165 *Spiraea alba* Du R Narrow-leaf Spiraea Bern Twp, Fairfield Co. E S Thomas

1202 1 *Chaenomeles lagenaria* Koidz (Cydonia japonica Hort) Japanese Quince. Spreading from cultivation "A large patch in a pasture lot probably started from the fruit" Liberty Twp, Highland Co Katie M Roads

1239 *Baptisia leucantha* T & G. Large White Wild-Indigo West Union, Tiffin Twp, Adams Co D R Dodd

1278 1 *Meibomia laevigata* (Nutt) Ktz Smooth Tick-trefoil Liberty Twp, Jackson Co, Coleraín Twp, Ross Co Floyd Bartley and Leslie L Pontius

1291 *Lespedeza nuttallii* Darl Nuttall's Bush-clover Liberty Twp, Jackson Co Floyd Bartley and Leslie L Pontius

1311. *Lathyrus myrtifolius* Muhl Myrtle-leaf Marsh Pea Buckeye Lake, Licking Co, Columbus, Franklin Co Wm C Werner

1316 *Clitoria mariana* L Butterfly-pea Kettle Hills, Fairfield Co E S Thomas and Chas Goslin

1322 *Phaseolus polystachyus* (L) B S P Wild Bean Cyuahoga River, Akron, Summit Co Wm C Werner

1334 *Sullivantia sullivantii* (T & G) Britt Sullivantia Fultonham, Muskingum Co Wm C Werner

1343 *Ammannia coccinea* Rottb Longleaf Ammannia Circleville Twp, Pickaway Co Leslie L Pontius and Floyd Bartley

1344 *Rotala ramosior* (L) Koehne Rotala Circleville Twp, Pickaway Co Leslie L Pontius and Floyd Bartley Baumgardner's Pond, Jackson Twp, Franklin Co Floyd B Chapman

1355 *Rhamnus lanceolata* Pursh Lance-leaf Buckthorn Hudson, Summit Co Wm C Werner

1365 1 *Ampelopsis heterophylla* (Thunb) S & Z Variant leaf Ampelopsis From Eastern Asia Escaped along a railway embankment, near a nursery Painesville, Lake Co Wm C Werner

1373. *Nemopanthus mucronata* (L) Trel Mountain-holly Lake Twp, Ashland Co Leslie L Pontius and Floyd Bartley

1391 *Schmaltzia crenata* (Mill) Greene Fragrant Sumac Kingsville, Ashtabula Co L E Hicks

1392 *Toxicodendron vernix* (L) Ktz Poison Sumac Washington Twp, Lucas Co Also in Swanton Twp Louis W Campbell

1427 *Quercus marilandica* Muench. Black-Jack (Oak) McArthur, Vinton Co E S Thomas

1482 *Salix humilis* Marsh Prairie Willow Cedar Swamp, Champaign Co Robert B Gordon

1484 *Opuntia opuntia* (L) Karst Common Prickly-pear Patton Twp, Ross Co Floyd Bartley and Leslie L Pontius Rollersville, Sandusky Co C W Horton

1488 1. *Schizophragma hydrangeoides* S & Z Schizophragma Escaped near Painesville, Lake Co Wm C Werner

1495 *Grossularia oxyacanthoides* (L) Mill Smooth Gooseberry Painesville, Lake Co. and Cedar Swamp, Champaign Co Wm C Werner

1496 *Grossularia hirtella* (Mx) Spach Low Gooseberry Near Hudson, Portage Co Floyd Bartley and Leslie L Pontius

1497 *Grossularia reclinata* (L) Mill Garden Gooseberry Painesville, Lake Co Wm C Werner

1503 *Epilobium strictum* Muhl Downy Willow-herb Painesville, Lake Co Wm C Werner

1505. *Epilobium adenocaulon* Haussk Northern Willow-herb White's Gulch, Liberty Twp, Jackson Co Floyd Bartley and Leslie L Pontius

1507. *Oenothera oakesiana* Robb Oakes' Evening-primrose Painesville, Lake Co Wm C Werner

1513. *Kneiffia longipedicellata* Small Long-pedicelled Sundrops Edge of a swamp Marshal Twp, Highland Co Katie M Roads

1523 *Myriophyllum heterophyllum* Mx Variant-leaf Water milfoil In marsh at Geneva, Ashtabula Co L E Hicks

1529 *Citrullus citrullus* (L) Karst Watermelon Commonly spontaneous along railroads and in yards Hillsboro, Highland Co Katie M Roads E Conneaut Beach, Ashtabula Co L E Hicks

1534 1 *Aristolochia clematitis* L Birthwort Escaped From Europe Perry, Lake Co Fred J Tyler

1538 *Ledum groenlandicum* Oeder Labrador-tea Thriving on Cranberry Island, Buckeye Lake, Licking Co Clara Roush Probably planted there by Dr Freda Detmers

1539 1 *Azalea canescens* Mx Hoary Azalea Burton Twp bog, Geauga Co L E Hicks, F B Chapman, and C Dambach

1547 *Chamaedaphne calyculata* (L) Moench Leather-leaf Thriving on Cranberry Island, Buckeye Lake, Licking Co L E Hicks Probably planted there by Freda Detmers

1553 *Chimaphila umbellata* (L) Nutt Pipsissewa Two miles north of Brinkhaven, Jefferson Twp, Knox Co E M Herrick

1565 1 *Oxycoccus oxycoccus* (L) MacM Small Cranberry Near Beach City, Sugar Creek Twp, Stark Co W H Camp

1566 *Gaylussacia frondosa* (L) T & G Blue Huckleberry Remove from the list W H Camp who is making a special study of our Vacciniaceae considers its range as not extending into Ohio "It does not occur outside the Atlantic drainage and the low costal plain of the Gulf Coast "

1572 1 *Gilia capitata* Dougl Capitate Gilia From the Pacific coast states Escaped in a pasture lot where it is abundant Hillsboro, Highland Co Katie M Roads

1577 1 *Phlox carolina* L Carolina Phlox The variety is *P carolina triflora* (Mx) Wherry "Edge of woods" Henley, Scioto Co Katie M Roads Also Edgar T Wherry See below

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The following notes and records on species of Ohio Phlox have been received from Prof Edgar T Wherry of the Univ of Pennsylvania, who is a special student of this group

1574 *Phlox maculata* L is now divided into two subspecies, *P maculata odorata* (Sweet) Wherry, the northern, and *P maculata pyramidalis* (Smith) Wherry, the southern one In Ohio both occur, and although the boundary lies at approximately 40 latitude, there is much intermingling on both sides of this line The most frequent and best known in the state is *P maculata odorata* The following records for *P maculata pyramidalis* have been seen Adams—E Lucy Braun Clark—both subspecies in O S U Herb Clermont—both subspecies in O S U Herb Fairfield—Lancaster, in U S National Herb Franklin—Darby Creek west of Columbus, E T Wherry Gallia - apparent intermediates between the two Greene—O S U Herb Hamilton- apparent intermediates between the two Hocking O S U Herb Mahoning Youngstown, Cornell U Herb Scioto—E Lucy Braun Stark Canton, U S National Herb The northern subspecies also represented in O S U Herb

1576 *Phlox glaberrima* L The specimens represent the variety *Plox glaberrima interior* Wherry Apparently all but two published records of *P glaberrima* in Ohio really represent *P carolina* The two which stand are Lucas- Swanton Twp, Mo, Bot Garden Herb Wood - Bowling Green, Moseley Herb

1577. *Phlox ovata* L The complete record for the species in Ohio is Fulton and Highland, O S U Herb Lucas—Oak openings, U S National Herb, O S U Herb

1577a *Phlox ovata carolina* (L.) Wherry Change to No 1577 1. *Phlox carolina* L. Carolina Phlox Wherry has accepted the Linnean name and has established the variety *P carolina triflora* (Mx) Wherry. The county records are Adams—Beaver Pond, Beech Fork, Cedar Fork, Turkey Creek, E Lucy Braun. Butler—North of Oxford, O S U Herb, Previously identified as *P glaberrima* L Highland—West of Fort Hill, Floyd Bartley and Leslie L Pontius Pike—Byington, Floyd Bartley and Leslie L Pontius Scioto—three-fourths mile S E of Pink E T. Wherry.

1579 *Phlox divaricata* L Most of the Ohio material seen is the typical phase of the var *P divaricata canadensis* (Sweet) Wherry, with notched corolla-lobes, but Miss Braun reports a colony with entire lobes in Adams Co

1582 a *Phlox subulata australis* Wherry, Bartonia 11·27 1929 This is the basis of several reports of *Phlox brittonii* Small in Ohio. Apparently all collections from south of latitude 40 degrees ten minutes represent this plant Herbarium material in other than the Ohio State Univ collection is referred to here. Adams—Laurel Knob, Peach Mt., E. Lucy Braun Delaware—two miles W of Harlem, E. T. Wherry Fairfield—Lancaster, in Gray Herb Highland—Stultz Hill, three miles N of Sinking Springs, E T Wherry, W of Fort Hill, Brush Twp, Floyd Bartley and Leslie L Pontius Licking—two miles W of Newark, E T Wherry Ross—Liberty Twp, Floyd Bartley and Leslie L. Pontius

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1624 *Gentiana crinita* Froel Fringed Gentian Bern Twp, Fairfield Co E S Thomas, C F Walker, and Robt Goslin.

1630 *Gentiana villosa* L Striped Gentian Liberty Twp, Jackson Co Floyd Bartley and Leslie L Pontius

1655 *Gonolobus laevis* Mx Sandvine Van Wert Co Said to be a bad weed on two farms E N Transeau

1672 *Physalis pubescens* L Low Hairy Ground-cherry In an orchard, Marshal Twp, Highland Co, Katie M Roads

1673 *Physalis pruinosa* L Tall Hairy Ground-cherry In a field near May Hill, Adams Co Katie M Roads

1687 *Penstemon pallidus* Small Downy White Beard-tongue Brush Twp, Highland Co Floyd Bartley and Leslie L Pontius

1693 *Chelone montana elatior* (Raf) P & W Mountain Turtle-head Eagle Mills, Vinton Co Leslie L Pontius and Floyd Bartley Old Man's Cave, Hocking Co John H Schaffner

1701 1 *Gratiola viscidula shortii* Penn Viscid Hedge-hyssop Rock Run and White's Gulch, Liberty Twp Jackson Co Floyd Bartley and Leslie L Pontius Also Rock Run R B Gordon

1735 *Castilleja coccinea* (L.) Spreng Scarlet Painted-cup Sphagnum Swamp Mantua Twp, Portage Co Almon N Rood.

1747 *Catalpa catalpa* (L) Karst Common Catalpa Mineral springs, Adams Co Leslie L Pontius, and Edw. S Thomas

1765 *Amsinckia intermedia* F & M Orange-flowered Amsinckia "Introduced in a nursery" Painesville, Lake Co Wm C Werner

1792 1 *Verbena hybrida* Voss Common Garden Verbena Escaped near Saybrook, Ashtabula Co Commonly cultivated. Lawrence E Hicks

1802 *Scutellaria serrata* Andr Showy Skullcap Conkle's Hollow, Hocking Co E M Herrick S E Corner of Jackson Co L E Hicks

1817 *Mentha alopecuroides* Hull Wolly Mint Conneaut, Ashtabula Co. L E Hicks.

1829 1 *Koellia verticillata* (Mx) Ktz Torrey's Mountain-mint Liberty and Coal Twps Jackson Co Leslie L Pontius and Floyd Bartley. Braceville Twp, Trumbull Co Almon N Rood, Barnesville, Belmont Co Emma E. Laughlin

1832 *Koellia mutica* (Mx) Britt Smooth-toothed Mountain-mint. Harpersfield Twp, Ashtabula Co L E Hicks

1844 *Meehania cordata* (Nutt) Britt. Meehania Perry Twp, Gallia Co L E Hicks, E. S. Thomas, and C. F. Walker

1854 1. *Stachys arenicola* Britt Sand Hedge-nettle. On dry, sandy, clay bank; near Conneaut, Ashtabula Co Lawrence E Hicks

1862. *Galeopsis tetrahit* L Common Hemp-nettle Plymouth, Ashtabula Co. L. E Hicks

1872 *Salvia pitcheri* Torr Wild Blue Sage Oak openings Springfield Twp, Lucas Co Emily and Bernard Campbell.

1878 *Plantago arenaria* W. & K. Sand Plantain. Growing in cinders along railroad. Perry, Lake Co Fred J Tyler

1888 *Aralia hispida* Vent Bristly Sarsaparilla. Phelps Creek, Ashtabula Co. L E. Hicks, F B Chapman and C Dambach

1892. *Hydrocotyle umbellata* L Umbellate Marsh-pennwort Lake Punderson, Geauga Co L E Hicks and F B Chapman

1894. *Eryngium aquaticum* L. Rattlesnake-master. Kettle Hill, Bern Twp, Fairfield Co. Chas and Robert Goslin

1901. *Torilis anthriscus* (L) Gmel. Erect Hedge-parsley. Painesville, Lake Co. Wm. C Werner

1935.1. *Cornus rugosa* Lam Round-leaf Dogwood Painesville, Lake Co. Wm. C Werner.

1942 *Cynoxylon canadense* (L) Dwarf Dogwood Painesville, Lake Co. Wm C. Werner

1956 *Galium boreale* L Northern Bedstraw Bog at Kennard, Champaign Co E. S. Thomas

1963.1. *Galium labradoricum* Wieg. Labrador Marsh Bedstraw. Sphagnum bog; abundant. Mantua Twp, Portage Co Almon N Rood

1980. *Viburnum cassinoides* L Withe-rod Near Beach City, Sugar Creek Twp, Stark Co W H Camp

1991 *Lonicera oblongifolia* (Goldie) Hook Swamp Fly Honeysuckle Penn Line Bog, Ashtabula Co L E Hicks

2031 1. *Zinnia elegans* Jacq Zinna Spontaneous along the road Liberty Twp, Highland Co Katie M Roads.

2039 a *Rudbeckia laciniata hortensia* Bail Golden-glow In a pasture lot, western part of Scioto Co. Katie M Roads

2057. *Helianthus strumosus* L Paleleaf Wood Sunflower In Prairie Pitt Twp, Wyandot Co Robert McCormick and Edw S Thomas

2070 *Cosmos bipinnatus* Cav Cosmos Escaped to waste ground north of Columbus, Franklin Co John H Schaffner. In Scioto and Ross Counties Katie M Roads

2082 *Coreopsis lanceolata* L. Lanceleaf Tickseed Painesville, Lake Co Wm C Werner

2084 *Coreopsis major* Walt Greater Tickseed. Introduced in a nursery Perry, Lake Co Wm C Werner

2099 *Gaillardia pulchella* Foug Gaillardia Escaped at Jefferson, Ashtabula Co L E Hicks

2116 *Grindelia squarrosa* (Pursh) Dun Broadleaf Gum-plant Pickaway Twp, Pickaway Co Leslie L Pontius and Floyd Bartley

2116a *Grindelia squarrosa serrulata* (Rydb) Steyermark Our specimens of Grindelia from Huron and Muskingum counties belong to this variety, as determined by Julian A Steyermark of the Missouri Bot Garden

2125 *Solidago odora* Ait Sweet Goldenrod White's gulch, Liberty Twp, Jackson Co Leslie L Pontius and Floyd Bartley

2128 *Solidago rigidiuscula* (T & G) Port Slender Showy Goldenrod Harrison Twp., Champaign Co E. N Transeau, M B Trautman, and Edw S Thomas

2131 1 *Solidago altissima* L Tall Goldenrod Painesville, Lake Co Wm C Werner

2136. *Solidago neglecta* T. & G Swamp Goldenrod Northfield, Summit Co Fred J. Tyler

2139. *Solidago ohioensis* Ridd. Ohio Goldenrod. Bern Twp, Fairfield Co E. S Thomas

2156. *Aster drummondii* Lindl Drummond's Aster South of O'Shaughnessy Dam, Washington Twp, Franklin Co Edw S Thomas

2157. *Aster undulatus* L. Wavy-leaf Aster Green Twp, Monroe Co, Marietta, Washington Co, Elk Run Twp, Columbiana Co, Union Twp, Knox

Co E S Thomas Liberty Twp, Jackson Co Floyd Bartley and Leslie L Pontius

2172 *Aster salicifolius* Lam Willow Aster On prairie. Big Island, Marion Co Robert McCormick and Edw S Thomas

2189 1 *Eupatorium album* L White Thoroughwort Liberty Twp, Jackson Co Floyd Bartley and Leslie L Pontius

2195 *Eupatorium aromaticum* L Smaller Snake-root Liberty Twp, Jackson Co Leslie L Pontius and Floyd Bartley

2198 1 *Kuhnia glutinosa* Ell Glutinous False Boneset Liberty Twp, Ross Co. Floyd Bartley and Leslie L Pontius Kennard, Champaign County, E S Thomas

2202 *Lacinaria spicata* (L) Ktz Dense Blazing-star Tuscarawas Twp, Coshocton Co Frank B Selby

2223 *Artemisia ludoviciana* Nutt Western Mugwort Paint Twp, Highland Co, Katie M Roads Jasper, Pike Co L E Hicks

2235 *Synosma suaveolens* (L) Raf Sweet-scented Indian-plantain. Bern Twp, Fairfield Co E S Thomas, C F Walker and Robt Goslin

2255 *Centaurea jacea* L Brown Star-Thistle Thompson, Geagua Co J G Binnig

2259 *Centaurea maculosa* Lam Spotted Star-thistle Roadside weed Painesville, Lake Co Fred J Tyler and Harriet B Tyler

2278 *Hieracium marianum* Willd Maryland Hawkweed Stow corners, Summit Co Floyd Bartley and Leslie L Pontius

2282 *Hieracium pratense* Tausch Field Hawkweed North Central Trumbull Co. L E Hicks and F B Chapman Burton Twp, Geauga Co Chas Dambach

2285 *Hieracium greenii* Port & Britt Green's Hawkweed Conneaut, Ashtabula Co L E Hicks

2285 1 *Crepis pulchra* L Small-flowered Hawksbeard Manchester, Adams Co. From Europe Conrad Roth

2300 *Lactuca villosa* Jacq Hairy-veined Blue Lettuce Clarksville, Clinton Co, Fort Ancient, Warren Co, Peach Mountain, Adams Co, Ripley, Brown Co, Cincinnati, Hamilton Co Katie M Roads Buchtel, Athens Co Len Stephenson.

Physical Geology.

This book is not to be confused with the one with the sam title by Longwell This new book is based on Physical Geology by Longwell, Knopf & Flint It follows the same order as the parent text and differs considerably from the other "Outlines" The Chapters are as follows: I, Geology, the Science of the Earth, II, Weathering as a Part of Erosion, III, Streams and Valleys, IV, Subsurface Water, Lakes and Swamps, V, Glaciation, VI, Wind as a Geologic Agent, VII, The Sea; VIII, Sedimentary Rocks, IX, Igneous Rocks and their Mode of Occurrence, X, Volcanoes and Volcanism; XI, Diastrophism and Its Effects, XII, Earthquakes, The Earth's Interior, XIII, Metamophism, XIV, The Structure and History of Mountains, XV, Land Forms, XVI, Mineral Resources, Appendix A, Minerals, B, Topographic Maps

The divorcing of Wind from Weathering is a great help because where the two are considered in one chapter the student often becomes confused and gets the impression that wind erosion is weathering The inclusion of Lakes and Swamps in the same chapter as Subsurface Water may lead to the same confusion although the text is very clear The Chapter on Mineral Resources is a wise inclusion as is the Appendix on Topographic Maps The authors have made an excellent abridgement of their Physical Geology and we feel that where the shorter text is desirable that this new Outlines is very usable and well arranged —Willard Berry

Outlines of Physical Geology, by C R Longwell, A Knopf and R F Flint v + 356 pp New York, John Wiley and Sons, 1934. $3.00

THE PRESENT STATUS OF CRYOLITE AS AN INSECTICIDE

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Columbus, Ohio

INTRODUCTORY.

For many years arsenicals have been used as stomach poisons for the control of chewing insects These were first discovered accidentally and at that time (about 1860) arsenic was used in a rather soluble form in spray materials like Paris Green and London Purple. In view of the injury to foliage caused by these materials and the consequent limited way in which they could be used for insect control a direct effort was made in 1885 in connection with the Gypsy Moth problem in Massachusetts to find an arsenical which was comparatively insoluble. As a result Arsenate of lead was first made and used in 1892 to control chewing insects and this was adopted as a standard material and was recommended and used almost exclusively for the control of chewing insects until the period of the world war Then a demand was made for a cheaper arsenical because of the high price of lead. At that time calcium arsenate and other cheaper materials were manufactured But these contained a larger percentage of water soluble arsenic than could be tolerated by plants and continued to injure foliage In 1925 the toxic effects and the cumulative toxicity effect of both lead and arsenic upon the human body were being recognized by toxicologists

Although the British government as early as 1903 had fixed a tolerance of 1.429 mg of As_2O_3 residue per kilogram of food stuff (equivalent to 01 grams per pound) this was practically ignored until 1925 when England threatened an embargo on American fruit This was soon followed by the establishment of the same tolerance on both fruits and vegetables by the U. S. Pure Food and Drug Administration Although the lead tolerance has been changed for 1934 to 0 019 grains of lead per pound, the arsenic tolerance of 0 01 grains of arsenious oxide has remained as in 1933

In view of this situation there has been widespread search for substitutes both in the field of organic contact insecticides and in an attempt to find a good nonarsenical stomach poison.

The ideal insecticide should be a substance with a high acute toxicity to a wide variety of insects, be non-injurious to plants and have no effect upon man. This will probably never be attained since all three of these are fundamentally alike biologically. In view of the lack of such an insecticide we have been required to consider these upon the basis of their relative toxicity to man and select an insecticide which seems to be the lesser evil.

On this basis fluorine compounds have been thoroughly tested during the past few years and two especially, cryolite

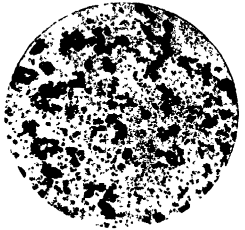

FIG. 1. Showing the variation in the size of particles of natural cryolite when ground. (Greenland)

and barium fluosilicate, have seemed to fit more nearly the requirements and be most promising because of their margin of safety on foliage, their relatively high toxicity to insects and their relatively low toxicity to man when compared with arsenate of lead

PHYSICAL AND CHEMICAL PROPERTIES.

Cryolite (Na_3AlF_6) is one of the fluoalumnates of an alkali metal. The other possible combinations are postassium hexafluoaluminate (K_3AlF_6) Ammonium hexafluoaluminate $(NH_4)_3AlF_6$ and lithium hexafluoaluminate (Li_3AlF_6).

Insecticides containing water insoluble double fluorides of the alkali metals with Aluminum are obtained by treating

water insoluble Aluminum compounds such as Al_2O_3 with alkali metal compounds such as KOH in suspension in the presence of water and gaseous H F or its aqueous solution and drying and comminuting the gel thus formed (Carter 14).

Cryolite occurs in two forms, natural and synthetic It occurs in Greenland as a native fluoride of Aluminum and sodium More than 10,000 tons are used annually for the manufacture of aluminum, the fused mineral being used as the bath for the electrolysis of alumina to the metal. Cryolite is also used as flux in the manufacture of white Portland cement,

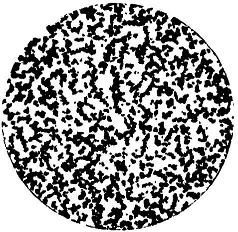

FIG. 2 Showing the uniformity of size of particles in synthetic cryolite. (Jungmann and Co product)

in the enameling of iron ware and in the manufacture of opaque white glass.

The natural cryolite when ground is a heavy powder with uneven sized particles (Fig 1) and is therefore not well adapted to insecticidal purposes.

The synthetic powdered material is light and nearly uniform in composition (Fig 2) and has a solubility of 1 gram to 1 639 cc of water It is available in commercial quantities It contains the following chemicals

Sodium aluminum fluoride	98 20%
Silica	71%
Sodium sulphate	36%
Iron oxide	06%
Moisture	64%

Both natural and synthetic cryolite are almost transparent in water suspensions Cryolite appears soluble because the refractive indices of water and cryolite are nearly identical.

When properly washed during the process of manufacture, suspensions or solutions of these compounds in water give a practically neutral reaction and as their solubility is low they are less likely to injure or burn plant foliage than such compounds as the fluosilicates Considering their fluorine content alone as a measure of toxicity they compare favorably with the fluosilicates and metallic fluorides which have a definite insecticidal value.

Aqueous solutions of Barium Fluosilicate have a corrosive effect upon spray pumps In order to overcome this situation the Grasselli Chemical Company have obtained a patent (No 1,931,367) which covers the addition to their Barium Fluosilicate of a slightly water soluble substantially neutral fluoride Synthetic cryolite is a material of this type and can be used for this purpose.

THE RELATIVE TOXICITY OF SOME FLUORINE COMPOUNDS AS STOMACH INSECTICIDES

In attempting to estimate the relative toxicity of the more important fluorine compounds Shepard and Carter (61) have determined the median lethal dose range of each material on the basis of mg per gram. The median lethal dose of acid lead arsenate is about 0 09 mg. per gram and is given here in order that the relative fluorine toxicities as specified below may be compared on that basis:

		Solubility at 25° C grams per 100 cc	Medial Lethal Dosage Range mg. per gram
FLUORIDES—			
Sodium	NaF	4 054	0 11–0 15
Manganese	MnF_2	186	20– 40
Lead	PbF_2	066	25– 40
Magnesium	MgF_2	013	57
FLUOSILICATES—			
Sodium	Na_2SiF_6	762	10– 13
Potassium	K_2Sif_6	177	07– 10
Barium	$BaSiF_6$	025	09– 12
FLUOALUMINATES—			
Sodium	$Na_3Al\ F_6$	061	05– 07
Potassium	$K_3Al\ F_6$	158	08– 10
Ammonium	$(NH^4)_3Al\ F_6$	1 031	11– 14

It will be noted from the above figures that sodium fluoaluminate or cryolite shows the lowest range median lethal dose and is therefore practically twice as toxic relatively as arsenate of lead

COMPATIBILITY OF THE FLUOSILICATES AND CRYOLITE WITH ARSENICALS

The use of combined arsenates and fluorine compounds has been suggested in the hope that additional insect control might be secured and that the arsenical residue might also be reduced.

Carter (11) has published certain data concerning these combinations He finds that fluosilicates in solution have an acid reaction and in general are much more soluble than the arsenates used in insect control In solution they are used at the rate of 1 pound each to 45 8 gallons of water. Severe injury to vegetation may be caused by excessive amounts of soluble arsenic or by solutions having an acid reaction The solutions were analyzed for both of these factors and he found that with lead arsenate there seemed to be a tendency for the fluorine compounds to form less soluble arsenic than is formed in tap water alone The other fluosilicates and other arsenates were largely decomposed The presence of cryolite decreased slightly the amount of soluble arsenic formed by all the arsenates used in these experiments. Barium fluosilicate caused the formation of smaller amounts of soluble arsenic than the fluosilicates of sodium, potassium or calcium This was probably due to its lower solubility Cryolite gave a low acidity reaction with all the arsenates tested and it also showed a low soluble arsenic content when mixed with these materials.

COMPATIBILITY WITH FUNGICIDES.

It is frequently necessary to mix insecticides and fungicides together in the same spray in order to control insects and plant diseases Marcovitch has mixed cryolite at the rate of 1½ pounds to 50 gallons of water in a lime sulphur spray at the rate of 1 to 40 without causing injury When used at the same strength with Bordeaux mixture 3-3-50 no foliage injury was caused. Fish oil at the rate of 1 pound to 4 pounds of cryolite may be used safely as a sticker and greatly improves the adhesive qualities of the spray.

PLANT INJURY OR BURNING

Many types of chemicals cause foliage injuries when used as dusts or sprays. As a rule more injury is caused by the material in spray form and in general materials that are readily soluble in water are more apt to burn On the other hand a highly insoluble material usually shows poor toxicity and is not a good insecticide. The margin of safety between a good insecticide and a safe material upon plants is so small that only a few known chemicals even approach the required specifications. Cryolite with a solubility of 1-1639 and barium fluosilicate with a solubility of 1-3750 have proven relatively safe on foliage by tests conducted to date and have shown a rather high degree of toxicity to insects When used as a spray upon bean foliage at the rate of 2 or 3 pounds to 50 gallons, Howard, Brannon and Mason have shown they produce no injury. When used as a dust at the rate of 6 to 12 pounds per acre Marcovitch has shown there is no injury to bean or potato foliage, but that injury occurred when amounts greater than 20 pounds per acre were used

According to Marcovitch different plants will very ragarding their susceptibility to burning by fluorine compounds Cotton seems to be the most resistant, followed by beans, cabbage, apple, potato, tobacco, cucumber, peanuts, peach and smartweed The latter is unusually sensitive to fluorine compounds

Various workers attempting to control several different insect pests have found cryolite safe to most foliage in general Specific reference is made to these findings in several places under specific insects mentioned in the following discussion.

Barium fluosilicate is considered safer than cryolite by some investigators, but according to Dr N F Howard, burning resulted in several instances on bean during 1933 with Barium fluosilicate and W. L Brannon found dahlias injured by the same material during 1933

POISONOUS EFFECTS OF FLUORINE ON MAN AND ANIMALS

When fruits and vegetables are sprayed with fluorine compounds and ingested how poisonous are they to man? This question has been variously answered by different workers There is reason to believe that cryolite and barium fluosilicate are less toxic than sodium fluosilicate Experimental work by Sollman and others working with animals which were fed

sodium fluosilicate in large doses indicates that the soluble arsenicals such as sodium arsenite are nine times more toxic than sodium fluosilicate

Marcovitch has stated (44) that according to Gautier and Clausman the average spray residue of fluorine compounds contain less than 3 parts of fluorine per million of food stuffs while natural foods contain on the average 26.5 parts of fluorine per million Since therefore we are apparently consuming more fluorine in our daily diet than would be possible from the consumption of fruits and vegetables sprayed with fluorine, these sprayed materials should offer no additional health hazards.

Both fluorine and arsenical compounds have high acute toxic values as indicated by the following figures (Marcovitch 44)

Acute toxicities (from Kuhn (Trans Fourth Int. Ent. Congress 1928) and Muechlberger (Jour Pharm & Expt Ther. 1930).

	M I D	
Calcium arsenate	38 mg per Kilo (dogs)	Kuhn
Lead arsenate	500 mg per Kilo (dogs)	Kuhn
Lead arsenate	75 mg per Kilo (rabbits)	Muehlberger.
Sodium fluosilicate	150 mg. per Kilo (dogs)	Kuhn
Sodium fluoride	200 mg per Kilo (rabbits).	Muehlberger.
Barium fluosilicate	175 mg per Kilo (rabbits)	Muehlberger.
Cryolite	500 mg per Kilo (not fatal)	Marcovitch.

In considering the residue problem we are primarily concerned with Chronic toxicities According to Marcovitch the fluorine compounds are at least 100,000 times safer than lead arsenate in this respect, and possess a marginal safety factor over the average spray residue content of 75

The situation in California is apparently considered in the same light if we may judge from the following quotation taken from the 1931 Annual Rept of the Calif Agr Exper. Sta , concerning the problem of fluorine spray residues "From a number of chemical analyses made by the Bureau of Chemistry at Washington, D C , it would seem that on vegetables which are washed before marketing, there is not sufficient residue to be dangerous for human consumption even though dusted excessively."

On the other hand Carter (13) states that in the Pacific Northwest where there is very little rain during the growing

season and where as many as 6 or 7 sprays are applied ranging from 2 to 4 pounds per 100 gallons of water during each application, the spray residue builds up to a considerable amount especially when oils are used Under these conditions, the spray residue on fruit has run very high, but fluorine compounds do not leave as much residue on sprayed fruits as arsenical sprays However when oils are used considerable residues result The maximum found when barium fluosilicate was used was 0 927 grains of barium fluosilciate per pound of fruit This is equivalent to 53 9 parts per million Normal spraying however usually shows 0.15 grains of barium fluosilicate per pound (equivalent to 8 7 parts per million Washing usually leaves about 2 1 parts per million Cryolite contains 1 3 times as much fluorine as barium fluosilicate

Investigators have differed considerably regarding the use of fluorine in one form or another when fed to or injected in man and animals Baldwin (2) and McNally (40) have reported several cases of fluorine poisoning in man Blaizot (5) Wieland and Kurtzohn (77) and Marcovitch (45) studied the lethal doses of different forms of fluorine for rabbits. Heidenhain (31) has reported on the lethal effects of sodium fluoride in dogs. By using sublethal doses of fluorine in different forms, Sollmann, Schetter and Wetzel (69) Bergara (4), Shultz and Lamb (60) and McClure and Mitchell (38) observed an impairment of growth and feed consumption in rats.

Several investigators have studied the effects of fluorine on the different organs and tissues of the body Brandl and Tappeiner (9) could find no histological changes in the blood, liver, kidneys or muscles of a dog fed varying amounts of sodium fluoride The same investigators found no evidence of histological change in the bones. Sollman, Schettler, and Wetzel (69) were unable to find histological lesions in rats fed 8 mg. of sodium fluoride per kilogram of body weight daily for 9 weeks. Pitotti (51) observed a degeneration of the epithelium of the kidneys and a cloudy swelling of the liver in rabbits and guinea pigs fed lethal doses of sodium fluoride. Weinland (76) reported that the mucous membrane of a frog was killed by a 2.1 per cent solution of sodium fluoride. Goldemberg (23) reported that the feeding of sodium fluoride caused an increase in the size of the thyroid glands of dogs and rats, but these results could not be verified by Chaneles (15) and Tolle and Maynard (74).

Several investigators, Schulz and Lamb (60) McCollum, et al (39) Bergara (4) and Tolle and Maynard (74) have shown the specific effect of fluorine on the teeth of rats The incisors became soft, elongated, and lost their normal pigmentation The teeth of dairy cattle also became soft and showed excessive wear when rock phosphate containing fluroine was fed according to Taylor (73) and Huffman and Reed (33). The effect of fluorine ingestion on human teeth when obtained in water supply has been reported by Smith, Lantz and Smith (63, 64 and 65).

They found that mottled enamel of the teeth is endemic at St David, Ariz and has been produced in experimental animals by water from that region Chemical examination of the water showed the presence of 3 6—7 15 mg of fluorine per 1 of water while water from non endemic localities gave 0—0 3 mg

The production of mottled enamel is attributed to the ingestion of fluorine in water and not to the food supply The source is apparently rock phosphate and black mica both of which contain 3-5% of fluorine Concentrations of fluorine above 2 7 parts per millinon were definitely toxic when ingested with drinking water

Several investigators have attempted to find the effect of fluorine feeding on bone formation chiefly by using rock phosphate as a mineral supplement in animal nutrition. Hart and his associates (30) reported improved bone formation when rock phosphate was used to supplement low phosphorus rations for pigs On the other hand Forbes and his coworkers (19) found that the feeding of rock phosphate to pigs produced less dense and weaker bones than when no minerals, or minerals practically free from fluorine, were fed. The weaker bones were characterized by maximum magnesium and phosphorus content and minimum calcium and carbon dioxide percentages Reed and Huffman (52) demonstrated that the feeding of rock phosphate resulted in the thickening of the jaw and the metatarsal bones of dairy cattle. The work of McClure and Mitchell (38) showed an increase in the ash percentage of bones, accompanied by a slight decrease in the calcium content of the ash, in rats on high fluorine rations. Contrary to this work Tolle and Maynard (74) showed a decrease in the percentage of bone ash in rats fed a ration containing 1 8 per cent rock phosphate They furthermore reported that

phosphatic limestone, containing approximately 1 percent fluorine was equal to a mixture of limestone and steamed bone meal for growth and bone formation in the pig.

McClure and Mitchell (38) found that fluorine in the form in which found in rock phosphate; namely, calcium fluoride, depressed calcium metabolism in the pig and that excessive fluorine intake also decreased growth and feed consumption

Fluorine is a normal constituent of body tissues. This has been shown by Zdarek (80) Gaatier (22) Wrampelmeyer (79) Joblbauer (34) Harmes (29) and Sonntag (70).

Kick, Bethke and Edgington (36) have recently compared the feeding of fluorine salts with the natural mineral when each was used in comparable feeding experiments They found growth impaired, bones weakened, teeth softened, and similar physiological effects were produced in swine by both materials Rock phosphate however produced certain pathological changes in the kidney which sodium fluoride did not produce

The recent work of Phillips, Alvin, Hart and Bohstedt (50) gave evidence to show that chronic fluorine poisoning does not inhibit reproduction in the rat and therefore any unfavorable effect upon reproduction arises secondarily as the result of a systematic reaction to fluorine. No clear cut and positive evidence is available to show that chronic fluorine poisoning has a cumulative effect upon reproduction or other physiological processes from generation to generation for as long as 5 generations

The most striking thing about the experimentation with fluorine compounds upon animals is that the results obtained by apparently equally competent workers are highly contradictory which indicates that certain factors other than fluorine may have caused these differences. Also these workers have assumed that fluorine regardless of its source or condition should produce the same effect upon animal tissues whether ingested with water or food or injected into the body with a needle Furthermore the changes which might take place due to the medium of the plant as is known to occur in the case of certain other chemicals used upon plants has not even been considered It has been definitely demonstrated by field work that sodium fluoride and sodium fluosilicate are too soluble and too injurious to plants to be used generally in a

practical way, but that cryolite is insoluble and safe on plant foliage. Probably the same difference is to be found in the case of man but practically all of the experimental work performed to date has been done by using the soluble form, sodium fluoride. These experimental data as such are not applicable to the insoluble materials It should be stated also that the European laws have already differentiated distinctly between 1, acid fluorides such as Ammonium bifluoride and Sodium bifluoride which are considered highly poisonous; 2, soluble neutral fluorides such as Sodium fluoride and Sodium Silica Fluoride which are held as mildly poisonous; and 3, the insoluble fluorides such as Synthetic cryolite which is considered as non-poisonous

It should be borne in mind that the main question is the form in which fluorine appears If the fluorides were as poisonous as to justify the tolerance dosage of 0 01 gram per pound of fruit, it would be impossible to manufacture cryolite under present conditions as the workmen are obtaining many times that amount during each production without having ever suffered injury to their health Competent authorities also point to the fact that Calcium Fluoride which is similar to cryolite is generally and extensively prescribed in medicine Also enamel and similar wares are used extensively which average a cryolite content of 10% and neither of these sources have been considered dangerous to human health

In order to determine the relative toxicity of materials which cause acute poisoning or chronic intoxication in man it is necessary to experiment with as many forms of lower animals as possible and then assume that the toxicity in the case of man is no lower than in these experimental animals Different materials may also cause different symptoms in the same species of animal so that loss of hair or other similar conditions may preclude more marked symptoms If comparisons must be made, uniformity of experimental conditions should be adhered to This apparently has been done in the case of the feeding experiments conducted by Smyth and Smyth (66).

They have published comparative toxicity data showing that the fluorine compounds are less toxic than lead arsenate These experiments were apparently well planned and the best controlled of those dealing with fluorine compounds They compared the relative toxicity of fluorine and arsenical insecticides by means of feeding experiments conducted on white

rats for a period of 16 weeks As a basis for comparison they used behavior, appetite, fecundity, growth, tooth development and abnormality and organic pathology, and all of their data indicated that arsenical compounds are several times more toxic than fluorine compounds. According to their work the use of fluorine insecticides leaves a much wider margin of safety than the use of arsenical materials based on the relative weight of spray residue to the fruit and the consequent amount toxic to the consumer. These conclusions should probably be considered as a more conservative estimate.

There is still some doubt concerning the question of ingestion of small amounts of fluorine or arsenic The data available indicate that the extremely small amounts of arsenic that may be found on sprayed fruits are harmful when administered over a period of six months. On the other hand the continued feeding to guinea pigs of sodium fluoride in small amounts such as may be found on sprayed apples, appeared harmless even after several years It seems therefore that the poisonous nature of fluorine compounds in small amounts that may occur on sprayed fruits is negligible from the standpoint of human health as far as conclusive data are available

RESULTS OF EXPERIMENTAL WORK IN THE CONTROL OF INSECT PESTS.

During the past four years cryolite and several other forms of fluorine have been used extensively to test their effectiveness in controlling some of the most important pests of fruits and vegetables, especially in the United States and other agricultural areas. Three things have been sought especially

1. A non-arsenical substitute for lead arsenate and other arsenicals.
2. A material which gave a high toxic value in controlling insects.
3. An insecticide which gave very slight or no foliage injury.

A brief summary of some of the results obtained by various workers on specific insect problems is cited here Although both natural and synthetic cryolite have been used in these experiments, the greater part of this work has been performed with a synthetic cryolite known as Syncrolite and manufactured by Jungmann and Co.

The Codling Moth (*Carpocapsa pomonella*).

The Codling moth is probably one of the most difficult insects which the grower has to control at the present time, and the spray residue problem of lead arsenate has presented a puzzling situation. Newcomer (46) has found in his experiments at the Washington State Experiment Station that certain fluorine compounds are as effective as lead arsenate in the control of codling moth on apples in the arid regions of the Pacific Northwest. Three or four of these compounds have given rather satisfactory results. Cryolite and Barium fluosilicate are two of this number which are available and suitable for use. At present the cost of cryolite is slightly higher than lead arsenate. But it does not injure the plant nor does it affect the color, size or quality of the fruit. Furthermore the fluorine residues are easily removed with alkaline washes. They can be used satisfactorily in the second brood sprays (5th and 6th cover) at the rate of 4 pounds to 100 gallons of water combined with one pint of fish oil, or 3 pounds to 100 gallons of water with one gallon of summer oil'

In later investigations (47) he found that after July instead of oil being used with lead arsenate, cryolite may be used at the rate of 3 pounds to 100 gallons of water. In 1931 cryolite proved very effective and in some cases more so than lead arsenate.

Webster, Marshall and Hansburg (75) working in the same area found that arsenates with oils gave heavy residues but good control of codling moth They also state that spraying throughout the season with 3 pounds of natural cryolite to 100 gallons of water plus one quart of fish oil gave slightly better results than the normal lead arsenate sprays

Gross and Fahey (24) have reported synthetic cryolite to have marked insecticidal properties for codling moth, but its effectiveness decreases more rapidly than that of lead arsenate.

Barrett working in California (3) has carried on experiments for the control of the codling moth on Walnuts. He found that barium fluosilicate and synthetic cryolite are the only fluorine compounds of those tested (including a large series) which show promise for use in controlling this pest on Walnut. Used as a dust at the rate of 35% with 65% of a 400 inch mesh Talc each gave good results. Each gave about 90% control and neither gave foliage injury.

Pettey (48) working in South Africa found that in cases of severe infestation of codling moth lead arsenate at the rate of 1¼ pounds in 40 gallons of water applied fortnightly throughout the season is not satisfactory as a control for codling moth. If the arsenate of lead is doubled more satisfactory results are obtained in control, but the residue is difficult to remove. In using an artificial cryolite from Germany at the rate of 2 pounds with ¼ pint of fish oil in 40 gallons of water and applied at intervals of 3 weeks throughout the season he obtained more satisfactory results than with a similar normal program of lead arsenate alone. In addition it appeared to reduce infestations of mealy bug (Psuedococcus maritimus) considerably.

At a later date (49) he stated that artificial cryolite was not as effective as lead arsenate in controlling Codling Moth in Highveld orchards, but it caused no foliage injury, whereas the arsenate sprays did considerable damage. The results indicated that cryolite is more effective in control in arid summer coastal regions than in those where summer rainfall occurs

Joubert (35) working in South Africa found in 6 of 7 comparative experiments that cryolite sprays used at the rate of 2 pounds to 40 gallons gave them from 3 to 25 per cent better control of codling moth on pears than Lead Arsenate sprays.

The fruit growers in the North West depend upon using cryolite and similar fluorine compounds for the early season sprays, because when lead arsenate alone is used for all seven or more sprays it is impossible to prevent the lead arsenate residue from becoming greater than the tolerance limits (.014 gms for lead and .01 gms for arsenic).

Experiments on peach for the Control of Oriental Fruit Moth (Clydia (Laspeyresia) molesta Busk) and the Plum Curculio (Conotrachelus nenuphar Hbst).

The foliage of the peach is usually sensitive to arsenate of lead which has been used for plum curculio and the residue problem is difficult to overcome Defoliation of the tree has always been a problem with arsenate of lead In 1929 Swingle (72) showed that arsenic was found to act as a cumulative poison within the peach leaves Acid lead arsenate when used alone in proportions of 1 pound to 50 gallons caused very

severe injury even when soluble arsenic was as low as .04% as arsenic pentoxide.

Snapp (67) used sodium fluosilicate at the rate of 2 pounds to 50 gallons and found it very toxic to curculio but also to the fruit and foliage of the peach.

Subsequently, Marcovitch, Stanley and Anthony (43) found in experiments performed in Tennessee that cryolite sprayed plots showed no trace of injury. In 1929 and in 1930 as many as 7 spray applications did not give the slightest degree of burning at the rate of one pound to 50 gallons.

Barium fluosilicate was about as safe as cryolite but with fish oil soap gave defoliation. The curculio was controlled equally well with arsenate of lead and cryolite while the oriental fruit moth was controlled better with cryolite. The cryolite sprayed plot also showed a noticeable reduction of *Bacterium pruni* (bacterial disease of peach) and thus exhibited bacteriocidal properties. The more rapid insecticidal action of cryolite and barium fluosilicate is shown by the fact that 100% mortality results in two or three days when curculios are fed upon foliage treated with these fluorine compounds while arsenate of lead treated foliage upon which they fed did not cause 100% mortality for two or three weeks time.

After obtaining a complete defoliation with 4 arsenate of lead sprays Marcovitch and Stanley working in Tennessee (45) used barium fluosilicate and cryolite as substitutes for arsenate sprays in controlling the Oriental fruit moth and plum curculio on peach. They found that dusts were not as satisfactory as sprays, largely due to weather conditions and that four sprays of cryolite and sulphur gave satisfactory control of both pests.

Snapp and Thomson (68) working in Georgia on peach report that synthetic cryolite at the rate of 2 pounds to 50 gallons caused no injury to foliage or budwood and gave almost as good control as potassium fluosilicate. Cryolite was the least toxic of the three fluorines used and potassium fluosilicate was the most toxic. Wettable sulphur apparently increases the toxicity of these fluorine compounds.

Frost of Pennsylvania obtained unfavorable results by using Sodium aluminum fluoride for oriental fruit moth on peach at the rate of 3 pounds to 100 gallons of water. He states that considerable burning resulted and a high percentage of control was not obtained as it ranged from 37% to 80%.

The Walnut Husk Fly (Rhagoletes completa Cress).

The walnut husk fly is probably one of the two or three most serious pests of the walnut industry in California. It has been introduced rather recently Boyce (6, 7, 8) has been working on this project and making rather extensive control investigations during the past three or four years.

In 1930 the arsenicals tested were effective in causing insect mortality but all except the basic arsenate of lead caused foliage injury. The speed of their toxic action bears a direct relationship to their arsenic content and degree of solubility in water. During the same season cryolite in dust and spray form gave practically as good results as barium fluosilicate,

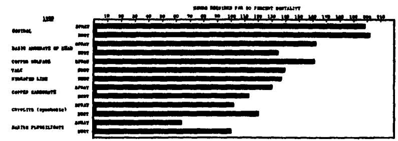

FIG 3 After Boyce, Monthly Bull Dept Agr Calif 20 686, 1931 Results of toxicity studies in 1930, showing number of hours required to bring about 50 percent mortality of adults in Rhagoletis completa Cress Data based on average of 55 experiments in which a total of 1,944 flies was used Average of 35 flies per experiment

but nothing else proved as satisfactory as these two materials (Figs. 3, 4, 5). Both were safe to use on plants. The speed of toxic action is correlated with the solubility of the material in water, the more soluble producing the more rapid lethal action Calcium fluoride and calcium fluosilicate were not effective

The results obtained the next year showed that cryolite and barium fluosilicate exhibited similar speed of toxic action and gave better results than the other materials tested. In speed of action natural cryolite was considerably inferior to the synthetic cryolite in these tests.

Later results (1932) showed that all of the arsenicals used (acid lead arsenate, basic lead arsenate, calcium arsenate, magnesium arsenate, manganese arsenate, sodium arsenite) except basic lead arsenate caused foliage injury and this one

was consistently slowest in speed of lethal action. Boyce makes the following statement, "of the fluorines tested sodium fluoaluminate (cryolite, synthetic) barium fluosilicate and potassium fluoaluminate were the most promising from the point of view of toxicity to the insect and tree tolerance" The accompanying diagram (Fig. 6) published by Mr. Boyce shows that these three were most effective in the order named, cryolite

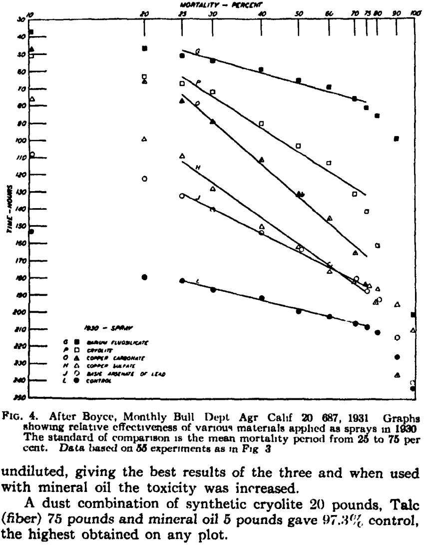

FIG. 4. After Boyce, Monthly Bull Dept Agr Calif 20 687, 1931 Graphs showing relative effectiveness of various materials applied as sprays in 1930 The standard of comparison is the mean mortality period from 25 to 75 per cent. *Data based on 55 experiments as in Fig 3*

undiluted, giving the best results of the three and when used with mineral oil the toxicity was increased.

A dust combination of synthetic cryolite 20 pounds, Talc (fiber) 75 pounds and mineral oil 5 pounds gave 97.3% control, the highest obtained on any plot.

Synthetic cryolite and barium fluosilicate were tested extensively and although both are quite low in adhesive qualities the incorporation of fish oil, vegetable oil or mineral oil rendered them satisfactory in this respect. Of these the mineral oil proved most desirable

In preparing a dust material, when diatomaceous earth is used as a diluent it has the decided advantage of being very light and bulky and the incorporation of oil for adhesive purposes does not affect its dusting qualities.

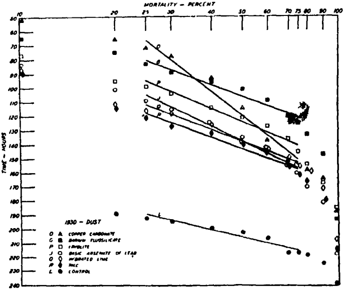

FIG 5 After Boyce, Monthly Bull Dept Agr Calif 20 688, 1931. Graphs showing relative effectiveness of various materials applied as dusts in 1930. Standard of comparison and data of 55 experiments as in Fig. 4

Mr Boyce states that "satisfactory control of the walnut husk fly may be obtained through the use of synthetic cryolite (97+ per cent sodium fluoaluminate) or barium fluosilicate" and recommends the following formulae.

1. As a spray:

   Cryolite (synthetic) or barium fluosilicate, 3 pounds.
   Mineral oil (95 seconds viscosity, 90% unsulfonatable), 1 quart.
   Water, 100 gallons.
   Use from 30 to 40 gallons per average sized walnut tree. This affords satisfactory coverage.

2. As a dust:
   Cryolite (synthetic) or barium fluosilicate, 30 percent.
   Diatomaceous earth, 65 percent.
   Mineral oil (95 seconds viscosity, 90% unsulfonatable), 5 percent.
   The dust method is more economical.

The Natal Fruit Fly (Pterandrus rosa).

Similar results to those obtained by Boyce were obtained by Ripley and Hepburn (54) in toxicity studies dealing with the Natal Fruit Fly (*Pterandrus rosa*). They also found that in speed of action, natural cryolite was considerably inferior to the synthetic cryolite The synthetic material

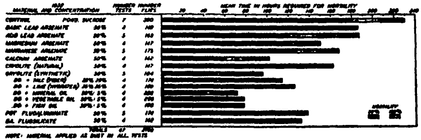

FIG 6 After Boyce, Jour. Eco. Ent 26· 821, 1933 Results of toxicity studies in 1932, showing relative mortality of various materials in comparison with different combinations of synthetic cryolite.

may be more effective because the bond between the elements of the molecule is not as great as in the natural product, thereby liberating the fluorine more readily.

Grape Berry Moth.

Runner (59) experimenting in Ohio found that cryolite and Potassium fluoaluminate failed to control the grape berry moth and in some cases caused injury to the grape and also to certain vegetables.

The Apple Curculio (Tachyterellus quadrigibbus).

Hammer of New York (28) carried on experiments to control this pest and found that cryolite used at the rate of 6 pounds to 50 gallons of water gave a high percentage of control (74 dead and 3 alive out of 100 released) Also he liberated curculios on a caged tree sprayed with cryolite and found only 12 apples out of 533 were injured by feeding. Lead arsenate gave slightly better control.

The Mexican Bean Beetle—Epilachna Corrupta.

Since the bean plant is quite sensitive to the effects of arsenate of lead and is easily injured, it has been difficult to secure a material which would give high toxicity of bean beetle without injuring the plant For several years Magnesium arsenate has been recommended and used as a control measure but magnesium arsenate is not a generally used insecticide and is consequently difficult to obtain in many states or regions where the bean beetle is a pest

Howard, Brannon and Mason (32) of the United States Dept of Agriculture Bureau of Entomology working in Ohio and Virginia have used fluorine compounds rather extensively over a three year period as substitutes for the arsenicals. They have found sodium fluosilicate to be too injurious to bean foliage and not sufficiently toxic to kill the insect On the other hand synthetic cryolite proved very effective for controlling this pest and increased the yields in the great majority of the experiments appearing to be beneficial to the bean plant. Under conditions of light infestation when used at the rate of 1 pound to 50 gallons and 2 pounds to 50 gallons excellent results were obtained When used under conditions of heavier infestations at a strength of 1 pound to 50 gallons it was not as good as Magnesium arsenate at the same strength, but at the rate of 2 pounds to 50 gallons it gave equally good results as Magnesium arsenate at the same strength. When used at the rate of 3 pounds to 50 gallons results were sometimes better than magnesium arsenate 2 pounds to 50 gallons. As a dust it is not entirely satisfactory but gave better results than an 80 per cent barium fluosilicate used under the same conditions.

Cryolite is apparently less injurious to foliage and safer than Magnesium arsenate especially in dry seasons and may in the near future be recommended by scientific workers in preference to it because of recent injury and lack of toxicity encountered in using magnesium arsenate and because cryolite is becoming more generally used and is available in most agricultural areas.

The Maize Stalk Borer (Busseola fusca Fall).

This pest is important in South Africa and has been studied by Ripley and Hepburn. They report (53) that cryolite gave

satisfactory control of the stalk borer as a spray at a 1-600 (by weight) strength. Although causing slight burning to the plant, it had the advantage over derris products of being a stomach poison and larvae need not necessarily be hit by it in order to be killed. It is also cheaper than derris products. In a later paper (55) they reported that cryolite when used on maize at the previously recommended strength and where 75 per cent of the stalks were infested even when applied a week late gave sufficient control of stalk borers to increase the yield of grain 26 per cent by weight. Cryolite being non-volatile remains in the plant until washed out by rain and when soap is added at the rate of 1 pound to 20 gallons the penetrating power and toxicity are increased Synthetic cryolite appears to be the most satisfactory stomach poison, although contact insecticides like derrisol have given good results and are recommended.

A Garden Caterpillar (Polia (Mamestra) Oleracea).

Speyer (71) made tests with various materials including several fluorides in an attempt to control a garden caterpillar (*Polia* (*Mamestra*) *Moleracea*) Arsenate of lead cannot be used on tomatoes in bearing Sodium fluoride injured the foliage. Barium fluosilicate had no effect on the larvae and no injury to the foliage Aluminum silica fluoride was toxic to the larvae and did not injure foliage but the cost was too high The most satisfactory results were obtained with synthetic cryolite in the form of a very fine powder used at the rate of 6 pounds to 100 gallons of water with the addition of 2 ounces of saponin as a spreader. The action may be largely a contact.

The Wattle Bagworm (Acanthopsyche junodi Heyl).

Ripley and Petty (56) worked with dust materials in an attempt to control the wattle bagworm in South Africa. Field and laboratory results on the basis of relative toxicity show them to be in the following order, the most toxic first:

1, Paris Green; 2, Sodium ferric fluoride; 3, Sodium fluosilicate; 4, Natural and synthetic cryolite; 5, Calcium arsenate; 6, Barium fluosilicate; 7, Calcium fluosilicate; 8, Schweinfurth yellow; 9, Copper carbonate.

Although showing greater toxicity the first three of these are usually dangerous from the standpoint of foliage injury while cryolite which gives a high toxic value among this group

is safer than any in the list with the possible exception of barium fluosilicate and certainly much safer than the first three.

Grasshoppers.

In using cryolite as a toxic material in grasshopper baits, Richardson and Thurber (57) found cryolite was not as toxic as arsenate of lead. The work of Marcovitch (41) also showed that cryolite gave rather poor control in the form of a bait.

Turnip webworm (Hellula undalis F).

Robinson of Alabama (18) working on this pest showed that cryolite was effective in killing all the larvae of this species under experimental conditions.

The Tobacco Hornworm. (Protoparce quinquemaculata).

Marcovitch and Stanley (42) used lead arsenate, cryolite, barium fluosilicate and potassium fluosilicate in comparative tests against tobacco hornworms and found cryolite to give almost complete control of this pest with lead arsenate and barium fluosilicate giving almost as good control in the order named.

Shade Tree Pests

The Bagworm (Thyridopteryx ephemeraiformis); The Fall Webworm (Hyphantria cunea); and the White Marked Tussock Moth (Hemerocampa leucostigma).

Tests made upon these three very important shade tree pests in Ohio by the author have shown that they can be very effectively controlled by Cryolite and without injury to the foliage of the Maples, Elm, Oak and other common shade trees and ornamentals which these usually attack. (Unpublished data.)

CONCLUSIONS.

The foregoing summary of literature and experimental work would indicate that.

1. Synthetic cryolite is superior to natural cryolite and in view of its physical and chemical properties is well adapted to insecticidal work.

2. Experimental work has indicated that cryolite has a relatively high toxicity to insects and gives the minimum of plant injury when properly used.

3. Fluorine when added in chemical form to food materials or injected into body tissues has given indication of chronic effects but other experiments conducted in a similar manner have given contradictory results. Also there is no available data regarding the effects of fluorine when plants sprayed with materials containing it were used as the source of food. Furthermore all experimental work to date has been performed with the soluble neutral fluorides and there is no data available upon the use of the insoluble fluorides although tolerance figures are placed upon these latter materials upon the basis of experimentation with the more soluble forms.

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First International Congress of Electro-Radio-Biology.

For the purpose of instituting among physicists, chemists, biologists, and physicians a close and profitable collaboration, indispensable for the advance of radio biology considered not as a branch of radiology or of biology, but as a separate science in itself, the International Society of Radio Biology is now preparing the organization of the First International Congress of Electro Radio Biology, which is to take place in Venice, in the Ducal Palace, in September, 1934, under the Presidency of H E Count Volpi di Misurata Minister of State

Plant Viruses.

The authors bring together in this interesting discussion what is known today regarding plant viruses They discuss the appearance and symptoms of virus effected plants, size of organisms and reactions of viruses to physical stimuli, and the relation of insects to the transmission of virus diseases as well as transmission in general, such for instance as those caused by grafting, by contact, either foliage or root, through seed or by pollen Other problems discussed are virus classification, plant resistance, or immunity to virus diseases, the movement of virus in the plant and the metabolic conditions of both the viruses and the hosts affected by them One of the important and interesting phases of this treatment is the discussion of methods and apparatus or equipment used in handling and trans mitting viruses In addition to summing up the work performed this will aid the research worker in further studies and help him determine the trend of research in this very important field The illustrations and diagrams are very helpful in the explanation of methods and apparatus —D M DELONG

Recent Advances in Plant Viruses, by Kenneth M Smith and F T. Brooks 423 pp Philadelphia, P Blakiston's Son & Co , Inc , 1934.

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ANNUAL REPORT

OF THE

OHIO ACADEMY OF SCIENCE

Forty-fourth Meeting

1934

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Affiliated with the American Association for the Advancement of Science

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NEALE F. HOWARD
ORVILLE T. WILSON
WM. A. P. GRAHAM
ROBERT A. KEHOE
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REPORT OF THE FORTY-FOURTH ANNUAL MEETING OF THE OHIO ACADEMY OF SCIENCE

WILLIAM H ALEXANDER,
Secretary.

INTRODUCTORY

The Forty-fourth Annual Meeting of THE OHIO ACADEMY OF SCIENCE was held on the spacious campus of the Ohio State University, the birthplace of the Academy, on March 30 and 31, 1934. This was the twenty-sixth time the annual meeting has been held within these walls; the Academy was therefore on familiar ground as well as in hospitable hands The local committee, under the fine leadership of its chairman, Dr. A. E. Waller, left nothing undone for the convenience and comfort of those in attendance. The attendance was good, the sectional programs attractive, the enthusiasm of members refreshing and the cordiality of the Ohio State University, as usual, delightful.

The presence of *The Central Ohio Physics Club*, Prof. G. A. Stinchcomb, of Heidelberg College, president, and Prof R. H. Howe, of Denison University, secretary, in joint session with the *Section of Physics and Astronomy*, was noted with pleasure by the Academy.

The Officers and Staff of *The Battelle Memorial Institute* extended a very courteous invitation to the members of the *Section of Chemistry* and their friends to visit the Institute, thus permitting them to see display exhibits of the Department of Chemical Engineering, including (a) Nomographic Charts in the Rayon Industry; (b) Fineness Determination of Portland Cement, etc.; (c) Classification of Limes.

Members also had the opportunity to inspect the *Heavy Water* installation of the Ohio State University under the courteous leadership of Dr. Herrick L. Johnston.

The annual dinner on Friday evening was served in elegant style in the beautiful banquet hall of the Faculty Club of Ohio State University. Dr. A. E. Waller presided over the affair in a delightful manner, introducing in a felicitous way Doctor McPherson, who spoke a few gracious words of greeting on behalf of the University and in the name of President Rightmire,

who was unavoidably absent from the city. Toastmaster Waller also introduced a number of distinguished visitors from other institutions and a number of the most eminent members of the Academy, but very diplomatically limited the speech-making to a minimum

The after-dinner courtesies having been well taken care of, the members and guests adjourned to the Lounge Room to listen to the Presidential Address on "A History of Ohio's Vegetation," illustrated with a number of beautiful slides. After the address, a delightful social hour was spent

MINUTES OF THE BUSINESS SESSIONS

(Reported by WILLIAM H HOWARD, Office Secretary, State Water Conservation Board, State House Annex, Columbus, Ohio)

First Session: March 30, 1934

FRIDAY MORNING

The business session was called to order at 9.30 A M by the President, Dr E Lucy Braun, of Cincinnati University

PRESIDENT BRAUN We seem to be particularly fortunate in this forty-fourth meeting of this organization to have such delightful outdoor conditions, and we shall certainly look forward to a larger attendance than we have this morning. We shall proceed at once with the business of the morning, as we have a number of things that will take considerable time.

The first announcement is a few committees to serve during this meeting:

The Committee on Membership—Dr Dwight M DeLong, Dr. Robert B Gordon, and Dr Alpheus W Smith

The Committee on Resolutions—Dr A E. Waller, Dr. Geo. D. Hubbard, and Dr G W Conrey.

The Committee on Necrology—Dr. F. C. Blake and Dr J. Ernest Carman

These are the only committees mentioned on the program, but there is an additional announcement in connection with the Nominating Committee. Dr Louis D. Hartson, who was to serve for the Psychology Section, is in Vienna, and Dr. Horace B. English will serve in his place.

We will now have the Reports of the Officers:

The Report of the Secretary will be heard first.

MR W. H ALEXANDER. Madam President, Members of the Academy, and Friends. This is the end of the eleventh year of the present Secretariate, and is very much like its ten predecessors (Report was read)

PRESIDENT BRAUN: You have heard the report of the Secretary; what is your pleasure?

Motion was seconded and carried to accept the Report.

PRESIDENT BRAUN: The next will be the Report of the Treasurer

DR. A. E. WALLER: I have here the report that will be submitted to the auditing committee It is a statement of our income and our expenditures In compliance with last year's recommendations, we changed the fiscal year to end January 1st, and consequently this is a report from April to January, and from now on our reports will cover the calendar year. I think we have had a pretty loyal membership, and our losses in membership have not been great, considering the circumstances (Report was read)

PRESIDENT BRAUN. You have heard the report of the Treasurer; what is your pleasure?

Motion was offered to receive the report pending action of the auditing committee

PRESIDENT BRAUN: The auditing committee has already gone over that

MR ALEXANDER: Under the amendment to our By-Laws, the Treasurer is directed to prepare his report for the year, ending December 31, select a competent accountant and let him audit the report, including also the Library and Research funds That has been done and the auditor's report was submitted to the Executive Committee last night, was read and accepted

DR. WALLER: There is a report of the Research Fund later on, and the report of the auditor, Mr Cornetet

MR ALEXANDER: Is not that just what you read?

DR WALLER Yes

Another motion was seconded and carried to accept the Report of the Treasurer

PRESIDENT BRAUN: The next order of business is the election by the Academy, by ballot, of a Nominating Committee of eight, one for each section, to report at the annual meeting in 1935. One procedure that has been followed in this connection is that some one makes a motion that the Vice-

Presidents serve in that capacity, and that the Secretary be authorized to cast a written ballot for those Vice-Presidents. Our By-Laws require a written ballot, and we can get around a long procedure this way.

Motion was seconded and carried that the Secretary be instructed to cast a ballot in writing for the Nominating Committee to serve in 1935, to consist of the Vice-Presidents of this 44th meeting.

MR. ALEXANDER: Madam President, I cast such ballot for Neale F. Howard, Orville T. Wilson, Wm. A. P. Graham, Robert A. Kehoe, Richard S. Uhrbrock, Ray L. Edwards, Roderick Peattie, and Wm. Lloyd Evans as the Nominating Committee for next year.

PRESIDENT BRAUN: The Nominating Committee has been elected. We will transpose the order of business and have the reports of the Standing Committees before New Business. The first of these reports is the Report of the Executive Committee, to be read by the Secretary.

The Secretary then read the report of the Executive Committee and at the suggestion of the President gave a brief resumé of the returns from Questionnaire Number One relative to the republication of Lynds Jones's "Birds of Ohio" and stated that a more detailed report would be published as a supplement to the Secretary's report.

DR. J. P. VISSCHER: Madam President, in order to get the matter before the house, I move that the President appoint a committee to consider further the republication of Lynds Jones's "Birds of Ohio."

PRESIDENT BRAUN: In view of the fact that the Secretary is anxious that every one rising to speak shall announce his name first, I will ask that this be done. It may not always be possible for the Chair to recognize the speaker by name, but if you will state your name when you rise, it will help to keep the record straight.

The motion offered by Dr. Visscher was seconded by Dr. Osburn.

DR. KEHOE: Any action taken on this matter will be postponed a full year, unless there is a power to act. I should like, if the original maker of the motion will permit, for this committee to be given power to act through the approval of the Executive Committee.

Dr. Visscher: Do I understand that they are to act jointly with the Executive Committee?

Dr. Kehoe: Yes.

Dr. Visscher: I am willing that the motion contain that provision.

Dr. Osburn: As the seconder of Dr. Visscher's original motion, I accept the amendment.

The motion as amended was put and carried.

President Braun: The members of that committee will be appointed later on. Is there anything else, Mr. Secretary?

The Secretary then gave a brief summary of the results of Questionnaire Number Two (published in more detail as supplement to the Secretary's report) and concluded by reading the recommendations of the Executive Committee regarding a subsidy to the Ohio Journal of Science. (See report of Executive Committee.)

President Braun: A motion to adopt the Report of the Executive Committee as a whole would be in order.

Dr. Waller: I move that the Report be accepted, and wonder, since the summary of the questionnaires is a digest of the opinions of the members, if it could be adopted as the concensus of opinion as worked out and tabulated, if it could be accepted as the basis of a policy for the Academy to follow.

The motion was seconded.

President Braun: The motion is to adopt the Report of the Executive Committee as read and to consider the tabulation of figures received with it on the questionnaires as representing the opinion of the Academy.

Dr. English: It seems to me we do not have anything else to do about it but to agree with the Executive Committee and that the publication of the Journal be continued. If people are not interested enough to express their views, then those views will have to be disregarded. I am heartily in favor of accepting the report of the Committee and continuing the Journal. This might be a recantation of my last year's remarks, but I think that the tabulation represents the feeling of the Academy. Some may consider this an injustice where out of over 500 questionnaires sent out, only 143 were returned. The vast silent vote is not here. I don't think they are being disregarded when probably they don't have an opinion.

President Braun: Do you wish to amend the motion that the report of the Executive Committee be adopted an

that the tabulated results of the questionnaires be spread upon the minutes?

DR ENGLISH I offer such a substitute motion

DR WALLER. I will withdraw my motion with the consent of the second (which was given)

PRESIDENT BRAUN: Dr English's motion directs that the tabulated results of the questionnaires be spread upon the minutes rather than as the opinion of the Academy

The motion was seconded and carried

PRESIDENT BRAUN Is there any report from the Publication Committee? Is there any member of the Committee present or any one here to make a report for the Committee?

DR BUDINGTON The report of the Publications Committee was presented to the Executive Committee last night The matter on the question of republishing the Jones books was referred to the action of the Executive Committee in that regard I think the recommendation of reissuing "Birds of Ohio" is the only item the Publications Committee has had under consideration the last year. The formal report submitted last night is the only report there is

PRESIDENT BRAUN We won't need a motion to accept an informal report The next report is that of the Trustees of the Research Fund. In the absence of Dr Osborn, the Secretary has the report Dr Smith, a member of the Trustees, requested the Secretary to read it

The report of the Trustees of the Research Fund was accordingly read by Mr. Alexander, who was then asked if any grants were given during the year, to which Mr. Alexander replied, "Obviously not."

Dr. Smith moved the adoption of the report, which was seconded by Dr Jones and carried

PRESIDENT BRAUN. The report of the Library Committee is next in order

Mrs Ethel M Miller, Chairman, read the report of the Library Committee.

PRESIDENT BRAUN. You have heard the report

Dr Budington moved that the report be accepted and that the Academy extend Mrs. Miller a hearty vote of thanks for her work

The motion was seconded and carried

PRESIDENT BRAUN There is still one committee, the Committee on State Parks and Conservation, which, unfortunately,

I believe has no report to make at this time, due to the absence of the Chairman, Dr Osborn, during the winter season when the Committee should have been active Is there any member of that committee present to make a report?

MR ROSCOE FRANKS. The Committee recommended two years ago that the birds of Ohio, especially the birds of prey, be given better protection The Committee made a report recommending that better protection be given the hawks and owls of Ohio This is one recommendation that did not go by the wayside Dr S Prentiss Baldwin took up the recommendation about a year after that and got public support behind a bill to abate the payment of bounties on hawks and owls The bill was passed by the legislature last year, and out of a possible 160 votes only five were against the bill; only five representatives were in favor of keeping the bounty We went to the State Legislature and told them the removal of the bounty would make a possible saving to the State of $135,000 a year That doesn't mean that we always paid out that much

We have had excellent co-operation from local newspapers *The Columbus Dispatch* did extra well, it published a full page article at the proper time Last December the *Dispatch* came out with another full page giving information about protecting hawks and owls in the State of Ohio Dr Baldwin has had 10,000 copies of this sheet reprinted Mr Palmer, State Chairman of the 4-H Clubs, has asked the club leaders to put this subject on one of their programs The *Dispatch* reprint will also go out to the granges, the farm bureau, the county agents, the Smith-Hughes teachers, and the sportsmen's organizations

I think this summarizes the results of this one recommendation of the State Parks and Conservation Committee made two years ago

PRESIDENT BRAUN. Are there any other remarks? Due to the early hour at which the committee announcements were made and, as some of the committees were not represented at the time, it seems desirable to have a re-announcement

Committee on Membership--Dr DeLong, Dr Smith, and Dr Gordon

Committee on Resolutions- Dr Miller, Dr Hubbard, and Dr. Conrey

Committee on Necrology—Dr Blake and Dr Carman.

The General Committee to act with the Executive Committee in the Matter of Publishing a Book on the "Birds of

Ohio"—Mr. E. S. Thomas, Dr. J. Paul Visscher, and Mrs. Margaret M. Nice.

Due to the lateness of the hour and the approach of the time of our address, we feel it will be best to postpone any new business and carry it over to the meeting tomorrow morning.

Regarding the dinner tickets, Dr. Waller, will you announce that they be sure to get their tickets early?

DR. WALLER: Any who have not yet secured their tickets, please do so at the registration table in the rotunda of this building. Frankly, we would like to have you do this by noon or shortly thereafter. A few people will not arrive until this afternoon We can only seat 200 inside the dining room, the Faculty dining room, and can take care of 40 outside that room if necessary. Dinner will be served at 6:30 promptly, and I am asking all members to assemble at 6:15. The dinner will be informal.

Miss McCabe is prepared to accept any dues that you are ready to pay, if you would like to pay them.

MR. ALEXANDER: I move that we adjourn to 9:00 o'clock tomorrow morning.

Motion was seconded and carried.

Second Session, March 31, 1934

SATURDAY MORNING

PRESIDENT BRAUN: The meeting will come to order. We shall proceed at once with the order of business—the reports of Special Committees.

The report of the Committee on the Election of Fellows will be read by the Secretary. (Report was read by Mr. Alexander.)

The next report will be from the Committee on Membership. (The report was read by Dr. DeLong, submitting 27 names.)

A motion was offered, seconded and carried electing the applicants to membership.

PRESIDENT BRAUN: We shall hear next from the Necrology Committee.

DR. BLAKE: I did not understand that reports would be called for at this time. Since our last meeting we have lost the following members: Dr. George B. Twitchell, Dr. F. L. Landacre, Dr. L. C. Scott, Dr. A. M. Bleile, and Mr. Frank R. Van Horn. Dr. Bleile presided when this Academy was organized.

The usual procedure of getting the necrology printed in the proceedings will be followed.

PRESIDENT BRAUN: The report will be submitted in writing?

DR. BLAKE: Yes.

PRESIDENT BRAUN: The next is the Committee on Resolutions.

DR. CONREY: Dr. Waller has something to offer.

DR. WALLER: I can give a partial report and fix it up later.

DR. CONREY: Dr. Waller has a resolution he would like to present.

DR. WALLER: There has been in the last few numbers of the Ohio Journal of Science a notice that the Federal Government has appointed a committee to investigate the conditions at the National Botanical Garden in Washington. It was noticed years ago that it was declining, and was not functioning as originally intended. The actual thing it does is to supply Members of Congress with cut flowers that could be obtained from any florist in perhaps a better way and at less expense. Dr. Hyde Beattie wrote about ten years ago on the abuses in existence in this Garden, and suggested that the name be changed to represent what it does. Now, that this Committee has been appointed, it would be well to go on record that we recommend that a scientific research committee be appointed to take care of this Garden as such gardens are taken care of in Europe. In England, France, Germany and other European countries, there is an exchange center at such gardens where materials can be sent for examination, comparison, or storage, for instance, at Kew Gardens, London. We will have to have some central place to send materials and specimens to have them examined, compared, stored, etc.

Now I have gotten all mixed up in my *whereases* and *resolves*. If you will let me read what I have and finish it later, I will turn it in ready for the record. (See page 246.)

DR. CONREY: I agree with the idea so far as it has gone, and we recommend that it be prepared and put in the form of a letter to Senator Fess.

Dr. Conrey then read a set of resolutions concerning courtesies extended the Academy and moved that the Resolutions be adopted.

The motion was seconded and Dr. Peattie suggested that reference to others not mentioned by Dr. Conrey be included. Motion was then put and carried.

DR BRAUN· We will next have the report from Representatives of the Joint Administrative Board of the Ohio Journal of Science

The report was given by Dr B S Meyer

PRESIDENT BRAUN What do you wish to do with the report?

A MEMBER. Madam President, it would seem to be well to have an explanation regarding the special item by Sigma Xi.

DR MEYER Two articles were printed out of order contrary to the policy of the Journal, and on the basis of one-half the additional cost. That has been one of the best numbers published in recent years

A motion was made and seconded to accept the report and the financial statement to follow Carried

PRESIDENT BRAUN. The Board recommends that $500 as an emergency fund be advanced

DR EDWARD L RICE· To keep up the size of the Journal so that we can catch up with the material on hand We have right now more than a year's material for the Journal at its present size

DR HAROLD E BURTT I wonder sometimes if the author couldn't cut down on his material and thereby make it shorter. I think there is a tendency to put in more material, more tables and pictures than are necessary I don't think every one reads all the articles anyway

DR MEYER· I know in one instance the authors are paying for the page space and the pictures, and I hope this arrangement will hold good in the future. I think the Editorial Board is interested in following what you suggest

DR JAMES P PORTER· I understand the author pays only half the cost of the plates and nothing for the tables. I wonder how that compares with other Journals I think it is a matter of psychology perhaps In most cases the author pays more than half the total cost of printing That is the case if the author wishes early publication In my own field of Psychology the material is increasing, just as in the Engineering Department of our Journal It would seem the proper action to take to confer on the Committee the power to establish some working code that would meet this situation in a practical way I do not know whether such action is wise or not, or whether it would increase the labors on the part of your committee. I might add this statement, that from my own point of view,

when the author does not have to pay he, of course, uses more space. That seems to me rather unfair in the case of the individual. I would like to say I do it myself, but I don't approve of it.

DR. E. N TRANSEAU: As a member of the Administrative Board, I can say this matter of curtailing the papers a bit has been discussed in the Board and the question was taken to the Editor and he proposes to do this Those in Physics and Chemistry, any of us who publish, know how condensed our articles must be to be accepted at all I believe the reduction in the number of pages per article can be carried out I still feel it is one of the problems of that Committee

DR CLARENCE H KENNEDY In the Journal of Economic Entomology articles are confined to six pages Many times an author puts ten pages of matter into one graph

A MEMBER. I presume if the Executive Committee can get by for less than $500, they will do so.

DR RICE The Committee will do anything it can to help in the present emergency All biological journals are swamped with material There is a movement on foot to try to meet the situation, and I presume one matter will be the problem of cutting papers The Journal of Economic Entomology has been more or less injured by putting a definite limit on articles If no limit is put on, then the editor is in trouble all the time A committee of three or four individuals to pass on the matter admitted to publication could take the blows and spread the responsibility around a little more At least half the articles could be boiled down to at least 60% of their length, and maybe to half It seems that this means work on the part of our committee. We are talking back and forth on it and are drawing up rules for our own Journal. It is a matter of education with the authors themselves Students do not know how to write; it is not taught in our Universities.

DR. WALLER: This hinges finally on the question of costs. It seems to me that the printers are getting more than the members of the Academy are We should investigate the matter of reducing the printing to a low cost We have almost given a constant contract to one printing concern– Spahr & Glenn. It is possible to discover whether there are other printing concerns who would give us the kind of Journal we would like. Of course, there are numerous things to be brought into consideration.

DR. KENNEDY: I would like to say a word about prices of printing. There has been pressure on me to get better prices. There are printers who will print at less cost over at Lancaster, Pa., and another printing concern in Wisconsin. They furnish a paper slightly off color and print the plates on the same paper; so we have stayed with Spahr and Glenn. They promise to give us the best prices we can get in the country. We have bids for a stack of printing. The routine is different with different concerns. On the average, the price paid at the end of the year gives us an idea of what has been happening. Spahr & Glenn have been very good and give excellent work.

DR. BURTT. We would like to ask Dr Kennedy for some remarks. In every kind of work, the bids are as near as we can compare them. In three separate cases the bids ran 20% to 30% higher than Spahr & Glenn It looks like our printing costs are at low ebb.

DR. KENNEDY: Some bids are 25% higher than we are paying.

PRESIDENT BRAUN: You have heard the motion to adopt the report of the Representatives of the Joint Administrative Board of the Ohio Journal of Science.

Motion put and carried.

PRESIDENT BRAUN: The next report is from the Representatives of Save Outdoor Ohio Council

DR. WALLER: I am reporting for both Dr. Herbert Osborn and myself We had two memberships until this year. These memberships cost $12 a piece. At the time we gave up the one, I was informed that only one representative could attend the Council meetings. The Save Outdoor Ohio Council is in conception an excellent institution It is a federation of societies I understand it has had very little effectiveness. That is due to the fact that other organizations with particular axes to grind in a legislative way run counter to new views held by any new and improved types of organizations. The management of Save Outdoor Ohio Council has not been adequate to cope with the situation when any bill was presented before the legislature, and consequently we have hesitated to continue our support for Save Outdoor Ohio Council, and the year's dues for this year still remain unpaid. We would like in connection with this report to be instructed as to what to do in regard to this bill for dues, and what our attitude should be with reference to Save Outdoor Ohio Council.

MR. E. S. THOMAS: I agree with what Dr. Waller has said. In conception it is an admirable thing. We have never had any co-ordination in the organization's interest in conservation so that it could render any effective work whatsoever. Each small organization has been functioning as a separate unit more or less ineffectively. I heartily agree with what has been accomplished with this organization. The management has been very unsatisfactory. Previous to the last legislature the council met and a number of recommendations of very desirable constructive conservation measures were proposed, but when the final recommendations to this organization went through, I was astonished to find that they were more or less petty things supported by a certain group

However, I do not believe that at the present time we should withdraw our support until we come to a conclusion as to whether or not we should further support the organization. I think it is our fault that we have not been as aggressive as certain other groups in the council At least if an organization of this kind cannot function, the various organizations connected with it are at fault. My suggestion is that we support the Save Outdoor Ohio Council for the present at least. I think a great many other delegates to this council realize that if something is not done, they will lose the support of many organizations. I believe the constituent organizations should get together and be a little more aggressive and give the management to understand that we must be recognized, and until we are recognized the council is not going to function as it should. We should support it and do all we can to support and further the policies and principles of conservation.

MR. EDW. L. WICKLIFF: It seems to me this Academy should in some way link itself with the new State Planning Board. We will not be able to do very much with legislation until we do that. In Iowa they put it up to the State Planning Board and were successful in mapping out a 25-year conservation program. If we want a legislative program passed in Ohio, I would suggest that this Academy link itself with our new State Planning Board, because the object of the Board is to plan State projects, of which conservation is one.

MR. FRANKS: I agree with Dr. Waller and Mr. Thomas concerning the Save Outdoor Ohio Council. The Federation of Women's Clubs dropped out a year or so ago. The Save Outdoor Ohio Council has certainly been ineffective and opposed

the bill to remove the bounty on hawks and owls, which was supported by more than 20 state-wide organizations, including the Grange, Farm Bureau, Ohio Association of Garden Clubs and the Ohio Sportsmen's Association.

Mr. Wickliff suggested that we connect with the new State Planning Board. We still need this central group. The Planning Board can make suggestions. If a bill we are interested in goes before the legislature, we still need some influential groups to get back of it. It might be advisable not to pay up our dues until we see if the Council is going to amount to something. I know of some 20 organizations more or less that are demanding action of the Council. I think there is a place for it, so possibly if I might make the suggestion again, we should retain our place in the Council or friendly relations with the Council.

DR. TRANSEAU: How is the Save Outdoor Ohio Council constituted?

MR. FRANKS: As I understand it, the Save Outdoor Ohio Council is a sort of federation of many different civic groups and associations. It might be considered a sort of congress of associations. There is supposed to be an election of officers every year or every two years. If we are not satisfied with the way the Council has been managed, constituent organizations such as this should assert themselves and not sit down and let the fish and game people run things. If the Women's Clubs, Garden Clubs and the Academy of Science and other organizations want to do something in connection with conservation, they must co-operate. When it comes down to election of officers, it might be well to lobby a little; other people are doing that. We don't need to make politics dirty, but we must go after what we want. I hope the constituent clubs such as the Garden Clubs, the Women's Clubs and the Academy of Science will be a little more aggressive in their demand for a sound conservation program. Through earnest co-operation we can build up strong support for sound conservation policies in spite of the fact that we may not realize it. I think a motion might be in order.

DR. VISSCHER: I think if we should demand a reorganization and go on record as refusing to pay dues until such reorganization is formed, we will get somewhere, and I so move.

MR. THOMAS: I have been thinking it might be well to leave this to the Executive Board. I am wondering if we with-

hold our dues whether we would be able to take part in their transactions.

A motion was offered to amend Dr Visscher's motion to leave the matter of paying the dues in the hands of the Executive Committee

The amended motion was seconded and carried.

PRESIDENT BRAUN: The report of the Nominating Committee will be given by Mr Walter Kraatz.

Mr. Kraatz read the report signed by all members of the Committee except three, one of whom signed by proxy, and two were reported as not available to sign.

PRESIDENT BRAUN· What shall we do with the report?

Motion was seconded and carried to accept the report

PRESIDENT BRAUN· The report of the Nominating Committee has been accepted and the nominees are hereby declared elected Is there any unfinished or new business?

DR BLAKE: I would like to offer a resolution on the report of Mrs Miller in regard to the funds received from the sale of Journals going to the Trustees of the Research Fund, namely:

"That the section of the constitution relative to money received from the sale of publications of the Academy being credited to the Research Fund be referred jointly to the Executive and the Publications Committees with instructions to prepare and present an amendment to the constitution of the Academy for action at the next annual meeting, if in the judgment of the joint committee it seems wise to do so, this motion to serve as notice of a proposed change."

On motion, seconded and carried, the resolution was adopted.

MR. WICKLIFF. Unfortunately, Dr Osborn, Chairman of the Committee on State Parks and Conservation, is absent, but so much has been done and we would like to have ten minutes to make a report.

Mr. Wickliff read the report, and stated that several conferences of conservationists had been held in Columbus and elsewhere during the past year, and concluded by saying: "It seems to me that in spite of the statement that nothing has been done in conservation, we have done more than in any other year"

PRESIDENT BRAUN. Is there any other business to come before us?

MR. FRANKS. Following up Mr. Wickliff's suggestion of a minute ago concerning our relations with the State Planning Board, I think it would be well for the Academy to formally tender its services in the form of conferences or scientific data.

PRESIDENT BRAUN: You might suggest that the matter be referred to the Conservation Committee of the Academy. It is just a friendly gesture, that we offer the information we might have as a group, and the Conservation Committee could work that out.

A motion was seconded and carried to instruct the Conservation Committee to offer its services to the State Planning Board.

DR. VISSCHER. Dr Herbert Osborn has been with us for 35 years, and I think it is fitting that we send him a message conveying our appreciation of his services and a word of regret that he is not with us this year.

PRESIDENT BRAUN: The Secretary will carry out the suggestion.

MR ALEXANDER: By some inadvertence, the name of Sister Mary Magdelen Crane was omitted from the list of new members, so I am adding it to the list, making 28 new members to add to our rolls. It is the fault of the Secretary, I am sure, that this omission occurred.

PRESIDENT BRAUN: Is Doctor Porter here?

A MEMBER. He has just left the hall to read a paper before a Sectional meeting.

On motion the meeting adjourned.

THE SCIENTIFIC SESSIONS

GENERAL AND SECTIONAL

The following is a list of the addresses and papers presented at the general and sectional meetings of the Academy as reported to the Secretary:

1. THE PRESIDENTIAL ADDRESS: A History of Ohio's Vegetation. E. LUCY BRAUN
2. THE INVITATION ADDRESS. Recent Geologic Methods of Measuring Time . . . . . WALTER H. BUCHER
3. Concerning Codonella cratera (Leidy), as Found at the Stone Laboratory, Put-in-Bay . . . . S. R. WILLIAMS, Miami University
4. Effects of Soft X-Rays on the Development of the Water Flea (*Daphnia magna*). . . . G SNIDER AND W. KERSTEN, University of Cincinnati (Introduced by NEALE F. HOWARD)
5. Summary of Parasites of Fish from Western Lake Erie, RALPH V. BANGHAM, College of Wooster
6. Modern Analysis of Human Pedigrees, LAURENCE H. SNYDER, Ohio State University
7. The Freshwater Jellyfish, *Craspedacusta ryderi*, in Central Ohio, with Remarks on the Distribution of this Species, W. J. KOSTIR, Ohio State University
8. A Curious Allusion to Mendel in Literature, EDWARD L. RICE, Ohio Wesleyan University

9. The Origin of the Heteroneurous Type of Lepidopterous Venation,
ANNETTE F. BRAUN, Cincinnati, Ohio
10. Notes on the Incubation of the Whitefish, *Coregonus clupeaformis* (Mitchill). . . . . . JOHN W. PRICE, Ohio State University
11. Cannibalism in an Ameba . . . . . JOHN C. LOTZE, Ohio State University
12. A Hawk Census from Arizona to Massachusetts,
MARGARET M. NICE, Columbus, Ohio
13. Insecticidally Induced Immunity in Plants against Sucking Insects,
D M. DELONG, Ohio State University
14. The Effect of Fluctuating Temperature on *Pyrgus communis* Grt (Hesperiidae, Lepidoptera) A W LINDSEY, Denison University
15. The Inheritance and Medico-legal Applications of the M-N Blood Groups. . HARRIET S. HYMAN, Ohio State University
16. Measuring Environmental Factors within Small Cages and Containers,
ALVAH PETERSON, Ohio State University
17 Otto Beutschli and His Contributions to Biology,
W J KOSTIR, Ohio State University
18. Studies of the North American Species of the Genera Balclutha and Agellus (Cicadellidae, Homoptera)
RALPH H DAVIDSON, Ohio State University
19 Ecological Observations of Ambystoma Opacum (Gravenhorst),
WILLIS KING, University of Cincinnati
(Introduced by NEAL F HOWARD)
20. Protozoan Parasites of the Orthoptera, with Special Reference to Those of Central and Southeastern Ohio,
FRANK M SEMANS, Ohio State University
21. The Breeding Birds of Northeastern Ohio,
LAWRENCE E HICKS, Ohio State University
22. Some Ecological Notes on the Vegetation of Northwestern Ohio,
R A DOBBINS, Ohio Northern University
23. The Change of Flora on the Pasture Lands Resulting from Fertilization,
D R DODD, Ohio State University and U S D A.
24. Thomas F Moses, Ohio Scientist from 1870 to 1894,
MARGARET B CHURCH, Urbana Junior College
25. The Effects of Recent Drouth Years as Reflected by the Growth Rings of Beech at its Western Distribution,
OLIVER D DILLER, Ohio State University
26. Studies on Virgin Hardwood Forest III Warren's Woods, a Beech-Maple Climax Forest in Berrien County, Michigan,
STANLEY A CAIN, Indiana State University
27. A Distorted Pollen Spectrum Due to Wind,
PAUL B SEARS, University of Oklahoma
28. The Tendency Toward Progression or Perfective Development in Plant Evolution . JOHN H SCHAFFNER, Ohio State University
29. Distribution of Original Forest Types in the Alleghany State Park, New York . ROBERT B GORDON, Ohio State University
30. Report on the State Herbarium. JOHN H SCHAFFNER, Ohio State University
31. Some New and Modified Histological Technics,
GLENN W. BLAYDES, Ohio State University
32. Some New or Critical Fungi H. C BEARDSLEE, Perry, Ohio
33 Nature of Injury to Forage Legumes Caused by the Potato Leaf-hopper, *Empoasca fabae* Harris,
HOWARD W. JOHNSON, U. S Department of Agriculture
34. The Algae of Baumgardner's Pond, Franklin County,
F B. CHAPMAN, Ohio State University
35. Growth and Development of Isolated Endosperm and Embryo of Maize,
LOIS LAMPE, Ohio State University
36. Correlation between Rough-Hairy Pubescence in Soybeans and Freedom from Injury by the Potato Leaf-hopper, *Empoasca fabae* Harris,
H W. JOHNSON AND E A. HOLLOWELL, U. S Dept of Agriculture
37. Some European Botanical Laboratories,
B S. MEYER, Ohio State University
38. Some Common Ohio Smooth Fungi, S S HUMPHREY, Ohio State University

39. A New Species of Ostracod from the Richmond, RALPH F. STRETE, Miami University
40. A Fossil Willow from Ohio . . WILLARD BERRY, Ohio State University
41. Preliminary Report on Spores from the Washington Coal (Permian) of Southeastern Ohio WILLARD BERRY, Ohio State University
42 Occurrence of the Corals Acervularia and Prismatophyllum in the Devonian of North America GRACE A. STEWART, Ohio State University
43. Igneous Rocks of the Blue Ridge in the Shenandoah National Park, A S FURCRON, Western Reserve University (Published with permission of the State Geologist of Virginia)
44 Nature and Origin of the Rhythms of Sedimentation in the Cincinnatian Rocks of Ohio W H BUCHER, University of Cincinnati
45. Mechanics of Low Angle Faulting as Illustrated by the Pine Mountain Fault, Kentucky JOHN L RICH, University of Cincinnati
46 Outline of the Section of Geology Spring Field Trip, WILLIAM A. P GRAHAM, Ohio State University
47. Lithologic Identity and Correlation E M SPIEKER, Ohio State University
48. Relationships Among the Lower Mississippian Formations of Ohio, Kentucky and Indiana, P B STOCKDALE AND H K KLEPSER, Ohio State University
49 Report on the Berea Sandstone at South Amherst, Ohio, with Special Reference to its Basal Contact FRED FORMAN, Oberlin College
50 Textural Variations in the Berea Sandstone of Northern Ohio—A Preliminary Report HARRY L THOMSEN, Oberlin College
51 Composition of Adams and Highland County Dolomite and Limestone, WILBUR STOUT, State Geologist of Ohio
52 The Geologic Section for Forty Miles Along the Min River, West China, GEORGE D HUBBARD, Oberlin College
53 Geologic Problems at the Norris Dam Reservoir of the Tennessee Valley Authority A C SWINNERTON, Antioch College
54 General Geologic Setting in the Muskingum Valley Area, WILBUR STOUT, State Geologist of Ohio
55 Geologic-Engineering Problems of the Muskingum Valley Project, WILLIAM A P GRAHAM, Ohio State University
56 A Buried Pre-Glacial Stream Channel in Muskingum County, ROBERT MCALLISTER, Muskingum College
57 Conditions of Sedimentation in Tuscarawas-Wills Creek Channel and in White Eyes Lake WILSON LAIRD, Muskingum College
58 Resistance to Tuberculosis— Race or Climate? C A MILLS, University of Cincinnati
59 The Nature of Osteogenesis Imperfecta, ITALO D PUPPEL, LOUIS E BARRON AND GEORGE M CURTIS, Ohio State University
60 A Chemical Method for the Determination of Pregnancy, J. PAUL VISSCHER AND DONALD E BOWMAN, Western Reserve University
61 Basal Metabolism and Iodine Excretion in Pregnancy, LENA ENRIGHT AND VERSA COLE, Ohio State University
62 A Study of the Permeability of the Placenta to Fluoride Ion, WILLIAM PRESTON, Ohio State University
63 Decomposition and Resorption of Chlorophyll in the Digestive System of Herbivorous Animals PAUL ROTHEMUND, Antioch College
64 Development of the Motor Nuclei of the Hindbrain of the Domestic Fowl (*Gallus Domesticus*) RUSH ELLIOTT AND L B ECKARDT, Ohio University
65. The Use of Polarised Light in the Study of Degenerating Myelinated Nerves H E SETTERFIELD, Ohio State University
66 The Energy Cost of Chinning the Bar, H E HAMLIN AND F A WATERMAN, Ohio State University
67 The Effect of Training on the Energy Cost of Exercise, FREDERICK A WATERMAN, Ohio State University
68. The Effect of Bilateral Adrenalectomy on the Ovary of the White Rat, ROBERT S MCCLEERY, Ohio State University

69. The Effect of Adrenalectomy upon the Normal Total and Differential White Cell Count in Albino Rats,
HYMAN A SHECKET, Ohio State University
70 Adrenalectomy and Blood Platelets,
DAVID L FRIEDMAN, Ohio State University
71. Changes in the White Blood Cell Picture, Red Blood Cell Picture and Specific Gravity of the Blood During Emotionally Excited States,
H. L KATZ AND L B. NICE, Ohio State University
72. The Spectrographic Measurement of Lead in Urine,
JACOB CHOLAK, University of Cincinnati
73 The Effect of Vital Dyes on Cell Proliferation and Growth,
HERBERT M. JACOBS, Ohio State University
74 Taste Organs in Birds. . H WEINGARTEN, Ohio State University
75. The Microscopic Structure of the Lung of the Frog (*Rana pipiens*),
HARLAM KNIERIM, Ohio State University
76. The Scientific Determination of a Course in Psychology for High Schools,
LOUIS A PECHSTEIN, Dean of College of Education, University of Cincinnati
77. The Reclamation of Twins Alleged to be Feebleminded,
FRANCIS N MAXFIELD, Ohio State University
78 Correlations among Measures of Mental Ability and Social History Data at the United States Industrial Reformatory,
CHARLES C LIMBURG, United States Industrial Reformatory
79. Some Findings on Fifteen Objective Tests of 350 College Freshmen,
JAMES P PORTER, L L HENNINGER AND CHARLES E FIDDLER, Ohio University
80. A Comparison of Emotional Attitudes of College Students in the Freshman and Junior Years,
LORIN A THOMPSON, JR , Ohio Wesleyan University
81 Determinants of Intelligence,
L DEWEY ANDERSON, Western Reserve University
82 Reliability and Validity in Conflict,
DOUGLAS E SCATES, Cincinnati Public Schools
83 Factor Analysis Techniques Applied to Scaling Problems,
PAUL HORST, The Procter & Gamble Company
84 Methods of Selecting Items in the Construction of a Valid Test,
ALBERT K KURTZ, The Procter & Gamble Company
85. Discussion led by HERBERT A TOOPS, Ohio State University
86 The Estimation of Intelligence from Photographs,
ELMER B ROYER, Ohio State University
87 Reliability of Audiometer Test with School Children,
JAMES P PORTER, RUTH C SCHISLER AND CHARLES E FIDDLER, Ohio University
88. The Relation between Reminiscence and Intelligence in Adolescents,
GORDON HENDRICKSON, University of Cincinnati
89 Differences in Reliability of Various Mazes for Normal and Operated Animals L. E. WILEY, Ohio Wesleyan University
90 Number Ideas of Pre-School Children,
JOSEPHINE H MACLATCHY, Ohio State University
91. Personality T A LEWIS, Denison University
92. The Influence of Memory in Radio Listening Surveys,
HILLIS LUMLEY, Ohio State University
93. Does the Reliability of an Achievement Test Depend upon Teaching?
HERMAN A COPELAND, Ohio State University
94 Program of the National Re-employment Service of Ohio,
STANLEY B. MATHEWSON, Director,
National Re-employment Service of Ohio, Columbus
95. Absorption of Formaldehyde Vapor in the Infra-red,
H H NIELSON, Ohio State University
96. The Electron Theory of Refraction and Dispersion for Elementary Classes . . . F G TUCKER, Oberlin College
97. What is meant by "Equivalence" in Crystal Analysis?
F C BLAKE, Ohio State University

98. An Electrostatic High Potential Generator,
H. C. Knauss and W. H. Bennett, Ohio State University
99. Some Knowledge Concerning Lightning,
Harold P. Knauss, Ohio State University
100. Some Laboratory Kinks . . . .. . C. E. Howe, Oberlin College
101. Self-Focusing Electron Streams,
W. H. Otto and W. H Bennett, Ohio State University
102. Demonstrations of a Model Gas Engine,
C. W. Jarvis, Ohio Wesleyan University
103. Untold Chapters of the Telephone Story. .. L W. Taylor, Oberlin College
104. The Invention of the Receiver . L. W. Taylor, Oberlin College
105. Static and Dynamic Demonstrations of Lissajous' Curves in Two and Three Dimensions . W. C Dod, Miami University
106. Phosphorescence of Glass Solarized by Soft X-Rays,
C. H. Dwight, University of Cincinnati
107. Geography and State Planning Alfred J. Wright, Ohio State University
108 The Muskingum Valley Project,
C C Chambers, Chief Engineer of the Muskingum Valley Project
109 Regional Planning for Ohio,
Walter J. Shepard, Director of the Ohio Regional Planning Board
110. The Geodetic Survey of Ohio . C. E Sherman, Ohio State University
111. An Aerial Survey of Ohio,
Fred L Smith, Director of the Ohio Bureau of Aeronautics
112. Some Geographic Aspects of our Economic Land Utilization,
C. C. Huntington, Ohio State University
113. The Soil Productivity Factor in Land Classification,
G. W. Conrey, Ohio Agricultural Experiment Station
114. Some Effects of Cleveland's Maladjustment to the Cuyahoga River,
C Langdon White, Western Reserve University
(Introduced by Roderick Peattie)
115 Some Cultural Features of the Ohio Landscape, R. B Frost, Oberlin College
116. The Conception of the Ideal Continent in Geography,
Guy-Harold Smith, Ohio State University
117 The Lake Port at Toledo,
Walter G. Lezius, Toledo University. (Introduced by E Van Cleef)
118 Sheffield, England· A Study in Urban Dynamics,
John H. Garland, Ohio State University
119. The Application of the Brooks-Humphreys Method for the Synthesis of Olefins to a Series of Octenes,
Melvin Dietrich and Cecil E. Boord, Ohio State University
120. The Synthesis of Phenyl Olefins. .J. R Harrod, Ohio Northern University
121. Some Mono- and Di-alkyl Esters of 2,2-di-(p-hydroxyphenyl) propane,
G R. Yohe, Ohio Wesleyan University
122. The Carbohydrate Fraction of Bacterium Aerogenes,
John R. Caldwell and H V. Moyer, Ohio State University
123. A New Method for the Preparation of Aldehydo-Sugar Acetates,
M. L Wolfrom and L. W. Georges, Ohio State University
124. The Action of Trityl Chloride on Glucose Ethyl Mercaptal,
M L. Wolfrom and C. C. Christman, Ohio State University
125. The Modification of Milk by Base Exchange Treatment,
J. F. Lyman, Ohio State University
126. The Use of Titanous Chloride in Quantitative Analysis,
R. V. Sinnett, Ohio Wesleyan University
127. Student Project No 2, A Portable Electro-metric Titration Apparatus,
H. Kesinger, D. Busch and K. Busch, Capital University
128. Salts of Diazoamino Benzene,
G. W. Watt and W. C. Fernelius, Ohio State University
129. Molecular Models in Inorganic Chemistry,
Richard F. Robey, Ohio State University
130. The Viscosity and Fluidity of Electrolytic Solution,
Raymond Hood, Miami University
131. Adsorption of Electrolytes at the Liquid-Vapor Interface of the Phenol-Water System and Its Relation to the Critical Miscibility Temperature,
Maurice B. Palmer, Kent State College

132. *The Heat Capacities of the Red and Yellow Forms of Mercuric Oxide*, H. L. JOHNSTON, A. B. GARRETT AND L. A. McDOWELL, Kent State College and Ohio State University
133. Surface Tension of "Dreft" . SANFORD YONOVITZ, Miami University
134. The Decomposition of Nitric Oxide Under the Influence of Ultra-violet Light . PAUL J. FLORY AND HERRICK L JOHNSTON, Ohio State University
135. The Preparation and Properties of Heavy Hydrogen and of Heavy Water. . . .HERRICK L. JOHNSTON, Ohio State University
136. Nomographic Control of Solutions in Rayon Manufacture, JOSEPH H. KOFFOLT AND JAMES R. WITHROW, Ohio State University
137. Lime—Scientific and Engineering Blunders in the Use of Lime in Industry, JAMES R WITHROW, Ohio State University
138. Water Supply and Treatment, C. P. HOOVER, Division of Water, City of Columbus
139. Experiments in Support of the Balanced-Layer Theory of Liquid Film Formation. . . . . C. W. FOULK, Ohio State University
140. The Focusing of X-Rays, CHARLES E WARING AND P. M. HARRIS, Ohio State University
141. Methods of Teaching Metallography, H. M. BOYLSTON, Case School of Applied Science
142. The Mechanics of Adherence of Glasses to Metals, R M KING, Ohio State University
143. Some Recent Advances in the Paint and Varnish Industry, J. M. PURDY, Chief Chemist, The Lowe Brothers, Dayton, Ohio
144 The Analytical Chemist and Alloy Steel Production, JOHN D SULLIVAN, Chief Metallurgical Chemist, The Battelle Memorial Institute, Columbus, Ohio
145. Metallic Diffusion . D J. DEMOREST, Ohio State University

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REPORTS

Report of the Secretary

COLUMBUS, OHIO, March 30, 1934.

To the Ohio Academy of Science·

And so this is the end of the eleventh year of the present secretariate! Like its ten predecessors, it leaves a rich heritage of delightful memories and inspiring associations! Some more delightful and inspiring than others, perhaps!

From the time the executive committee fixes the date and place of the annual meeting until the proceedings of the meeting are printed and distributed, the calls on the office of the secretary are very frequent, often daily, and but for the loyal, ready co-operation of the entire official family, might easily become burdensome. The affairs of the Academy originating in or referred to the office of the secretary have been taken care of just as promptly as our professional duties would permit and as efficiently as our limited ability made possible. We are only too conscious of our shortcomings, especially in the making of a program for the annual meeting. We desire here and now to record our sincere regret that we are not able to keep out all errors.

Until you have had the task of preparing a questionnaire that would, presumably, gather up the varied and complex views of some 500 persons and then the job of working these replies into a brief and intelligible report, you will never know "the trouble I've had!" The

bright and cheerful side of it, of course, is the fine spirit of co-operation one always finds in an organization of this kind. Thanks are due to those who, in the first place, assisted in the preparation of the questionnaire and also every member who took the time and trouble to fill it out and return it to the secretary. We suspect that the maker of a motion or resolution is not always aware of the labor and details involved in carrying it out. A more detailed report of the results of these questionnaires will appear as a supplement to this report.

It goes without saying, of course, that the membership of the Academy continues to feel the strain of the generally depressed condition of the country, but no more so, perhaps, than other similar organizations. We believe the action of the executive committee in temporarily waiving the provisions of Section 3, Chapter I (Non-Payment of Dues) had a wholesome effect on our membership As was to be expected, frequent changes had to be made in our membership list during the year; some losses, some gains, many changes in addresses. At our last counting, only yesterday, there appeared on our list 537 names, 177 of whom are fellows, and 264 are members of the American Association for the Advancement of Science. We are never sure, however, that we have a correct, up-to-date list.

A brief account of our Athens meeting was prepared for and published in *Science*

In closing this necessarily brief report, we desire to commend the fine efforts of the eight vice-presidents in the gathering of the material you see on the program before you We congratulate them on their success and each one whose name appears on the program One or two other names should have appeared on the printed program but for the inadvertence of the secretary. For this we are truly sorry.

And so our humble efforts of the year are before you. May you enjoy the 44th Annual Meeting, which compared with the first looks as if we are really growing'

Respectfully submitted,

WILLIAM H ALEXANDER,
Secretary

REPORTS ON QUESTIONNAIRES NUMBERS ONE AND TWO

(Supplemental to the Secretary's Report)

QUESTIONNAIRE NUMBER ONE

THE REPRINTING OF LYNDS JONES' "BIRDS OF OHIO"

The following motion by Professor E L. Moseley was approved by the Academy, viz

"That the Publications Committee be authorized to get an estimate of the cost of the publishing of the new edition of Lynds Jones' 'Birds of Ohio' and the decision as to publication be referred to the Executive Committee in conjunction with the Publications Committee "

Pursuant to this resolution, the Publications Committee has secured and laid before the Executive Committee considerable information regarding the proposed publication A book of approximately 300 pages, containing several groups of illustrations, probably colored, numerous line drawings of types that have distinctive markings of conspicuous sort, printed on good paper, adapted for use as a

text in ornithology courses, market price about $2 00, with advance order price to members of $1 00, is proposed

Before making a final, definite decision or recommendation regarding this matter, the Executive Committee desires the following information

1 As a member of the Academy, do you favor the publication of such a book by the Academy?
2 Would you care for personal copies? If so, how many?
3 What would be the probable sales to students in your institution, or society?

REPORT ON QUESTIONNAIRE NUMBER ONE

Of the 143 questionnaires returned, 15 made no reply to Number one Of the 128 who did make reply of some kind we find the following

Question 1.	Yes	99 (18 conditional)
	No	25
	In doubt	1
Question 2.	Part I Yes	83 (2 conditional)
	No	32
	Part II. (How many?)	99 (2 conditional)
Question 3.	"None"	19
	"Don't know"	30
	"Several"	4
	"Good" (sale)	2
	Total indicated sale	126 copies

Some Remarks

"Prefer subsidy, if any, go to the Journal "

"Thirty copies each year to O S U students "

"Ten copies every other year "

"Doubtful outside of State "

"None, I handle only babies "

"Fifty to one hundred copies or more might be sold to the Cleveland Bird Club at once "

"You should investigate the record of the Wheaton Club, in my estimation much more up-to-date "

"Columbus Audubon Society and Wheaton Club about 75 per year "

"If provided with good circular, will urge it on members of my Sportsman's organizations "

QUESTIONNAIRE NUMBER TWO

Subsidizing The Ohio Journal of Science with Academy Dues

Motion by Prof H E Burtt, seconded by Prof H B English, approved by the Academy

> "That this matter (subsidizing the Journal) be referred to the Executive Committee to canvass the members before the next meeting as to their opinions on the subject, and to go over it with the Publications Committee, and that the whole thing be referred to the next annual meeting "

For the information and guidance of the Executive and Publications Committees, you are respectfully asked to answer the following questions, viz

1 Have you ever published in the Journal?
2 If not, why not?
3. Do you plan to publish in the Journal in the future?
4 Approximately what percent of the articles in the Journal do you read?

5 How many persons do you know personally who, in your opinion, could be induced to join the Academy at $1 00, but who would not do so at $2 50?

6. Are you aware that the present fee of $2.50 pays your dues in the Academy for one year and for a Journal that costs about $4.00 to print?...... ....
7. If your membership in the Ohio Academy of Science did not include the Journal, and hence your only contact or reminder of the Academy was the annual meeting and the notices of this meeting, would your interest be sustained?
8. Do you feel that members receiving no publication of any kind from the Academy in the course of the year would feel their membership to be worth while?
9. Are you in favor of a single annual publication in book or monograph form (such as published by the Indiana Academy of Science) to take the place of the present Journal?
10. If granted the option would you take (Check one)
    (a) Membership without the Journal at $1 00
    (b) Membership and the Journal for $2 50
    (c) Some other arrangement (Specify)·
11 Do you favor· (Check one)
    (a) Continuing the present subsidy to the Journal?
    (b) Serving notice that the present subsidy be terminated beginning in 1935?
    (c) Reducing the subsidy? If so, how much?

REPORT ON QUESTIONNAIRE NUMBER TWO

Of the 143 questionnaires returned, all replied in some fashion to *Questionnaire Number Two* Not many attempted to answer in detail all 11 questions, but the replies in general were quite satisfactory. Our attempt to tabulate or analyze them is as follows:

Question 1:	Yes	58
	No	79
Question 2:	"No special reason"	1
	"Publish elsewhere"	3
	"Not qualified"	2
	"Does not reach my field"	2
	"Prefer national journals"	7
	"Other journals more suitable"	18
	"New member in the Academy"	4
	"No time to prepare"	1
	"Nothing ready"	14
	"Too expensive"	1
	"Do not do research"	1
	"No following in geography"	1
	"Not aware chemistry papers desired"	3
	"Paper accepted but did not appear"	1
Question 3:	Yes	68
	No	30
	Possibly	14
	Doubtful	10
Question 4:	1 to 10%	27
	10 to 20%	7
	20 to 30%	23
	30 to 40%	5
	40 to 50%	34
	50 to 60%	5
	60 to 70%	2
	70 to 80%	10
	80 to 90%	4
	90 to 100%	7
	Less than 1%	5
	None	3

Question 5:	None	66
	Very few	9
	1 or 2	5
	2 or 3	5
	4	1
	5 or 6	3
	7	1
	25 or 30	1
	Several	2
	Very doubtful	1
	$2 50 not too much	1
	Try it and see	1
	Money not a determining factor	1
	Membership would be doubled at $1 00 each	1
Question 6:	Yes	93
	No	35
	Doubter	1
	"Who pays the $1 50 difference?"	1
Question 7:	Yes	48
	No	85
	Doubtful	6
Question 8:	Yes	26
	No	100
	Doubtful	9
Question 9:	Yes	23
	No.	73
	Doubtful	6
	"If necessary"	1
	"If cheaper"	2
	"Do not know"	1
	"Prefer special Academy number with abstracts"	1
Question 10:	(a)	26
	(b)	103
	(c)	14

SUGGESTIONS

"One annual publication "
"Might have both (a) and (b) "
"Dues at $1.25 and Transactions "
"Favors the Indiana plan."
"Why not give all but 'Fellows' the options?"
"Publish the Journal quarterly with change in make-up."
"Semi-annual, or annual; all papers should be published "
"Membership and simple annual publication at $1 50 or $2 00 at most "
"Fees from the members in each section be used to publish papers in that section."

Question 11:	(a) Yes	103
	No	8
	(b) Yes	18
	(c) Yes	11
	"If so, how much?"	
	One-half	1
	None	2
	Enough to reduce dues to $2 00	1

Report of the Treasurer

COLUMBUS, OHIO, February 2, 1934.

Professor A. E. Waller, Treasurer,
The Ohio Academy of Science, Columbus, Ohio.

DEAR SIR:—Complying with your instructions, I have completed my examination of the Cash Account and statement of Receipts and Disbursements of The Ohio Academy of Science for the period from April 1, 1933, to January 16, 1934, and submit the following as my report of the Treasurer's Account:

Cash Balance April 1, 1933		$ 438 15
Income and Receipts:		
Dues	$937 50	
A. A. A. S.	138 50	
Interest—Government Bonds	74 34	
Library	44 95	
		1,195 29
Total		$1,633 44
Disbursements		
Botany Section	$ 6 00	
Zoology Section	8 08	
Geology Section	22 34	
Psychology Section	4 20	
Medical Section	14 00	
Ohio Journal of Science, Programs and Printing	954 00	
Postage	56 17	
Auditing	20 00	
Secretarial Services	41 00	
Executive Expenses	22 86	
Miscellaneous	8 27	
Wm. H. Alexander, Secretary's Honorarium	100 00	
Total		1,256 92
Cash Balance, January 16, 1934		$ 376 52

Cash Receipts have been traced to the depository and the disbursements have been verified by cancelled checks and found to be correct.

While I have not had access to the records of the Trustees of the Research Fund of the Ohio Academy of Science, a letter from Professor Herbert Osborn advises the funds of said Trustees remain the same as for the previous period with one exception, an increase of $8.78, showing the funds of this account as follows:

Balance in Ohio National Bank, May 8, 1933	$228 36
Income during year	8 78
Balance January 16, 1934	$237 14

This balance has been verified and found to be correct.

Respectfully submitted,

JAMES P. CORNETET.

Report of the Executive Committee

(By the Secretary)

COLUMBUS, OHIO, March 30, 1934.

The Executive Committee has held three executive committee meetings and two joint meetings, one with the vice-presidents as a Committee on the Election of Fellows, and one with the Publications Committee.

The first meeting of the committee was held at the office of the secretary on October 21, 1933, with all members present and by invitation Dr. Herbert Osborn, chairman of the Research Fund, and Mrs. Ethel M. Miller, chairman of the Library Committee.

The applications for membership of four persons, namely, Donald J. Borer, Robert Martin Goslin, Dorothy M. Johnson, and E. D. Scudder, were passed upon favorably and are hereby recommended to the Academy for approval.

By unanimous vote the suggestion made by the auditor in the case of the Library Fund (Proceedings, 1933, p. 246) was left in the hands of Mrs Ethel M Miller to work out in the best way possible.

The secretary was then instructed to arrange with a competent accountant to audit the treasurer's report for 1933 in ample time for the annual meeting of 1934, as per Section 3, Chapter V, of the By-Laws

It appearing from the treasurer's statement that certain Government bonds owned by the Academy had been called, the treasurer was authorized to exchange said bonds for other Government bonds, or bonds guaranteed by the Government, at the highest possible rate of interest In view of the serious responsibility imposed upon the treasurer and the executive committee by Section 2, Chapter II, of the By-Laws in the matter of the investment o Academy funds, it was further voted to appoint a committee of four, consisting of the treasurer, the secretary and two members not members of the executive committee. to advise with the treasurer in the matter of investments. The President appointed C. G Shatzer and M. E. Stickney as the two additional members.

It was also voted that the financial reports of the Trustees of the Research Fund and of the Library Committee should be included in the Treasurer's report and all submitted as one report to the auditor.

The question of reprinting of Lynds Jones's "Birds of Ohio" was considered at considerable length and after much discussion of the facts and figures submitted by the chairman of the Publications Committee it was unanimously agreed that the matter was not in shape for definite action at this time and it was therefore voted to refer the whole matter back to the Publications Committee with the request that it be put in a more concrete form as to *contents*, especially as to *colored plates*, *cost*, etc., and then resubmitted to this committee. It was further suggested that, in the meantime, the membership of the Academy and as far as possible other societies that might be interested in such a publication, such as Audubon Societies, etc., be canvassed in order to arrive, as far as possible, at some idea as to the real demand for a new issue of the *Birds of Ohio*.

The rather serious matter of delinquency in the payment of annual dues was called to the attention of the committee by the treasurer and in the general discussion that followed it was obvious that the committee was in full sympathy with the hard circumstances in which many members find themselves and was in no way disposed to deal harshly with any one. The discussion resulted in the unanimous adoption of the following motion:

That the provisions of Section 3, Chapter I, of the By-Laws (Non-Payment of Dues) be temporarily waived, and

That no member be dropped or privileges abridged until the arrearage has continued three years, except that the sending of the *Ohio Journal of Science* will be continued only to those who have paid their dues.

The treasurer was requested to have a portion of Section 3, Chapter I, of the By-Laws printed on the next issue of the notices to be sent to members regarding dues. It was also suggested that members should be advised of the change in the fiscal year.

Before the meeting adjourned, the treasurer, Dr. A. E. Waller, withdrew and at the same time submitted his resignation to the President, who laid same before the committee. Dr. Waller felt constrained to take this action because of his then rather precarious condition of health which he feared might prevent his doing his full duty as treasurer of the Academy. The committee, however, though fully appreciative of the reasons for this action on the part of the treasurer, was unwilling at this time to accept his resignation, but instead instructed the secretary to assure Doctor Waller of its entire willingness to furnish him all the assistance necessary to relieve him of the burdens of details of his office.

The treasurer was authorized to reimburse the out-of-town members of the Executive Committee for all actual expenses incident to attendance upon the official meetings of the committee.

The second meeting of the committee was also held at the office of the secretary on Saturday, January 13, 1934. One member was absent

The applications for membership of the following persons were approved and are now recommended for election: Miss Mabel Schramm, Cleveland; Miss Lois Lillick, Cincinnati; Miss Emily R. Hess, Ft. Thomas, Ky.

By unanimous vote it was decided to accept the invitation of the Ohio State University to hold the annual meeting of 1934 on its campus and Dr. A. E. Waller was asked to organize a local committee on arrangements and to report the names to the secretary for the approval of the president.

The question of an invitation speaker was taken up and it was agreed that we should have one outstanding scientist for the general scientific session on Friday morning. Several names were suggested and the final selection was left to the president and secretary after a careful canvass of the field. The choice is known to you and we hope will be heartily approved.

The first joint meeting of the committee was held last evening at the Deshler-Wallick Hotel, Columbus, when it met in joint session

with the Vice-Presidents of the Academy as a committee on the election of fellows. The results of this meeting will be reported later by the secretary.

The second joint session of the committee was called for last evening at the Deshler-Wallick Hotel to consider the matter of the publishing of the Lynds Jones's "Birds of Ohio," but the Publications Committee failed to appear.

The third meeting of the Executive Committee was held last evening at the Deshler-Wallick Hotel with all members present. At this meeting the applications of fifteen persons for membership in the Academy were approved and are recommended for favorable consideration by the Academy.

The report of the auditor of the treasurer's books was received and approved. This audit also included the reports of the research and library funds.

Consideration was then given for the third time to the matter of reprinting Dr. Lynds Jones's "Birds of Ohio," the results of the questionnaire on this subject were presented by the secretary, and while the committee highly favors the publication of some book of this kind, because of the many complex factors involved, especially the financial factors, finds it very difficult at this time to form a definite policy or recommendation to make to the Academy.

Concerning the publication of a book on the "Birds of Ohio," the Executive Committee desires to say that it has devoted a large part of three of its meetings to an earnest consideration of the matter and from the facts and figures submitted by the Publications Committee and from the information gathered from the questionnaires and other sources, is unanimous in the opinion that there is a field for a publication of this kind and while some progress has been made, we are not yet able to see a solution to financial problems involved nor are we yet sure as to just what such a book should include. We do recommend, however, that the matter be given further consideration and to this end we recommend the appointment by the President of the Academy of an advisory committee of three to co-operate with the Executive and Publications committees especially in reconciling the various views as to the contents and make-up of a book on the Birds of Ohio.

The results of Questionnaire Number Two (subsidizing the Ohio Journal of Science) were also laid before the committee.

Based upon these results, showing a surprising unanimity of opinion on the part of the membership in favor of the continuation of the Journal, the Executive Committee feels that it cannot do otherwise than recommend a continuation of the present subsidy to the Journal. We furthermore bespeak for the Editor and Editorial Staff of the Journal the hearty and loyal support of the entire membership of the Academy that we may have a larger and even better "Official Organ."

Respectfully submitted,

WM. H. ALEXANDER,
For the Committee.

Report of the Library Committee

COLUMBUS, OHIO, March 30, 1934.

To the Ohio Academy of Science:

The greater part of the work of the chairman of this committee during the past year has been of routine nature, such as correspondence, the care of the mailing list, and the sales Unfortunately, more names have had to be removed from the mailing list than usual on account of resignations of the members or non-payment of their dues The second cover page of each issue of the Ohio Journal of Science states that the Journal "is sent without additional expense to all members of the Academy who are not in arrears for annual dues." When times were better and some members would pay for two or three back years at once, it was felt that more or less leniency could be used concerning this regulation. But now that it is harder to pay for several back years at one time it has seemed only fair to the members who pay their dues promptly and to the management of the Ohio Journal of Science that this regulation be enforced. So if any member has not been receiving his copy of the Journal, this may be the explanation. All back numbers are very gladly supplied to the members when the Treasurer reports that the dues are no longer in arrears.

A few names have had to be taken off the mailing list as the members had moved and had failed to send their correct addresses. In some instances the cards sent by the post-office have been written so illegibly that they were not deciphered correctly. As the mail was then returned, those names had to be removed from the mailing list However, many of the members have been careful to send in their new addresses This is of great assistance in keeping the mailing list correct

The exchanges seem to be in a very satisfactory condition, for it has been necessary to claim very few periodicals because of their non-arrival or to replace copies of the Ohio Journal of Science that did not reach their destinations. A foreign shipment was made in June and another one last week There are now 371 institutions on the mailing list and they are sending nearly 500 periodicals on exchange. These make a very valuable part of the Ohio State University Library and many of them are much used by the faculty and students. Nine exchanges were dropped during the year and nine new ones were added, leaving the total number unchanged.

The stock of the Ohio Naturalist and of the Ohio Journal of Science has been kept in the University Library for many years As the numerous piles of assembled volumes and of the individual numbers had never been wrapped into parcels except those for the last few years, they had unavoidably collected a large amount of dust. It has long been realized that they ought to be wrapped, but nothing could be done about it for lack of help. Under the recent federal aid plan the library has had a large number of students assigned to it, so that it was able last week to put three onto the task of cleaning and wrapping the stock under my supervision. Complete inventory has been taken of the assembled volumes and of the individual numbers that have not been put into volumes. The exact figures of the inventory are not yet

available. They will range from 300 sets of some of the volumes of the Ohio Naturalist down to 50 sets of a few of the volumes of the Ohio Journal of Science, with no extra copies of one issue in volumes 25, 26, and 27. Very accurate work has been done by the students and the wrapped parcels present a pleasing appearance. The stock of the Reports and Special Papers of the Academy was counted and wrapped a few years ago, so that now all the stock is in good shape.

The sales for the preceding year had been quite disappointing, but they were even more so this past year, having amounted to only $18.55. Only 27 items were sold of which exactly one-third were Dr.Stover's "Agaricaceae of Ohio." This money has been given to the Treasurer. No formal financial statement is submitted this year as it was decided that the account was too small to be audited separately from the Treasurer's report. At the time of the last meeting in April, 1933, the bank balance was $48.14. It was thought best to withdraw this sum entirely at the rate of ten dollars a month which was the maximum sum then obtainable at the bank. This was done for May and June. Beginning with July only the current interest for each half year has been paid. As it was only seventy cents for the whole year with a tax of six cents, it was left in the bank, making a total on December 31, 1933, of $28.78. Altogether the bank dividends since 1926 have amounted to 33.53, which is a sum a little larger than the sale price of a complete set of the publications of the Academy.

The most outstanding feature of the whole year was the discovery that the money collected from the sales of the publications constitutes one of the sources of the Research Fund of the Ohio Academy of Science. It would have been wise if the constitution had been read years ago, for ever since the University Library has had charge of the sales of publications, such money, a total of $850 24, has been paid to the Treasurer of the Academy and has gone into the general fund The members of the present Library Committee have agreed that the constitution should be followed hereafter and that the sales money should be paid to the chairman of the Research Fund.

Respectfully submitted,

ETHEL M. MILLER,
Chairman.

Report of the Trustees of the Research Fund

COLUMBUS, OHIO, March 30, 1934.

To the Ohio Academy of Science:

In accordance with action of the Executive Committee a financial report of the Research Fund for the fiscal year ending December 31, 1933, was forwarded to the Treasurer for audit with his accounts and the items of that date showed cash balance from April, 1933, of $228.36, with receipts of $8.78, or cash balance on deposit of $237.14, and a total of assets, $1,974.64.

For information of condition at present time it may be added that receipts credited since January 1st of $49.78 brings our cash balance to $286.92 and total assets $2,024.42.

We believe that the condition of our invested funds has improved and that we may expect such returns as will justify limited grants in the near future

Respectfully submitted,

HERBERT OSBORN,
GEO. D. HUBBARD.

Report of the Administrative Board of the Ohio Journal of Science

COLUMBUS, OHIO, March 31, 1934.

To the Ohio Academy of Science:

Only one meeting of the Joint Administrative Board of the Ohio Journal of Science has been held since the last meeting of the Academy on February 16, 1934. Present were all members of the Board, the Editor and the Business Manager.

All of the present officers of the Journal were re-elected for the year 1934.

Motion carried the Board express its approval of the Editor's arrangement with Biological Abstracts whereby each author of a biological article in the Journal submits with his article an abstract for transmission to Biological Abstracts, and that the Editor be further instructed to approach other abstracting journals with a view to completing similar arrangements.

Motion carried that the Board recommend to the Academy that it consider a special grant of $500 00 to the Journal in order to assist in the maintenance of the Journal at its present size.

Motion carried that the Academy representatives, the Editor, and Mr Manchester interview President Rightmire with regard to the University's grant to the Journal.

Motion carried that a statement of the present status of the Ohio Journal of Science, and its relation to the various organizations connected with it be carried in the March, 1934 number of the Journal

The following financial report was presented by the Business Manager This account was audited and certified as being correct by a committee consisting of E N Transeau and E. L. Rice

FISCAL YEAR 1933
(The Ohio Journal of Science)

RECEIPTS

Balance from 1932	$ 170 20
Ohio State University Allowance	800 00
Ohio Academy of Science—Proceedings Cost, 1932	321 17
Ohio Academy of Science—Balance of Dues, 1932	100 50
Ohio Academy of Science—Proceedings Cost, 1933	221 00
Ohio Academy of Science—Dues, 1933	675 00
Special Grant, Ohio State Chapter of Sigma Xi	227 03
Special Grant, University of New Hampshire	40 00
Subscriptions	50 44
Sale of Back Numbers, etc	71 85
Authors' Payments for Plates	47 34
Total Receipts	$2,724 59

EXPENDITURES

Spahr and Glenn Co., Printing No 5 and No 6, Vol 32	$ 493 45
Spahr and Glenn Co, Printing Vol 33	1,612 85
Bucher Engraving Co	168 84
Postal Charges	120 69
Spahr and Glenn Co, Envelopes and Stationery	40 20
Hiss Stamp Co, Rubber Stamps	2 70
Labor and Clerical Assistance	8 60
Purchase of Back Number of Journal	1 00
Federal Check Tax	54
Total Expenditures	$2,446 17
Balance on hand at end of Fiscal Year	278 42
(Huntington National Bank, Columbus, Ohio)	
	$2,724 59

All actions of the Administrative Board during the past year have been unanimous.

Respectfully submitted,

B. S. MEYER,
Secretary.

Report of the Representative at the Academy Conference

(Boston, Mass, December 27, 1933)

COLUMBUS, OHIO, March 30, 1934.

To the Ohio Academy of Science:

The Conference at Boston was the best I think that it has been my privilege to attend and the discussions showed much enthusiasm and much interest in problems common to the State Academies A very full discussion followed the reading of a paper by Professor E C. L. Miller, of the Virginia Academy, on the teaching credit hours allowed for laboratory courses in comparison with recitation hours This is reported quite fully in the Conference communication and which is distributed from the Conference Secretary

Extracts from the report may be of interest and can be presented as fully as time permits

In case it is thought advisable I can prepare a condensed statement of the proceedings of the Conference for publication in our Academy Proceedings.

Respectfully submitted,

HERBERT OSBORN,
Academy Representative.

Report of the Committee on the Election of Fellows

COLUMBUS, OHIO, March 31, 1934.

To the Ohio Academy of Science:

The Committee on the Election of Fellows met at the Deshler-Wallick Hotel on Thursday evening, March 29, 1934, for the consideration of nominations to fellowship in the Academy. The nominations of the following members of the Academy were found to be in proper form, satisfactorily supported by documentary evidence and

duly countersigned, and each having received the required three-fourths vote of the Committee, were declared elected to Fellowship in the Academy, viz.:

STANLEY ADAIR CAIN (Indiana University).
WENDELL HOLMES CAMP (Ohio State University).
ARTHUR GLENN CHAPMAN (Ohio State University).
RAY CLARENCE FRIESNER (Butler University).
ROBERT BENSON GORDON (Ohio State University).
LAWRENCE EMERSON HICKS (Ohio State University)
PAUL JACKSON KRAMER (Duke University).
CLARENCE J. LEUBA (Antioch College).
MELVIN GILLISON RIGG (Kenyon College).
HIRAM FREDERICK THUT (Eastern Illinois State Teachers' College)
HARRY ELLSWORTH NOLD (Ohio State University).

Respectfully submitted,

WILLIAM H. ALEXANDER,
Secretary.

Report of the Membership Committee

COLUMBUS, OHIO, March 31, 1934.

To the Ohio Academy of Science:

Your committee finds the following applications for membership in the Academy in proper form and is pleased to recommend the election of the nominees to full membership:

ADAMS CLYDE S ; *Chemistry, Physics;* Antioch College, Yellow Springs, Ohio
ACQUARONE, PAUL; *Botany (esp Plant Physiology and Anatomy);* University of Akron, Akron, Ohio
BAUR, KATHARINE E , *Botany, Geology;* 2422 Highland Ave , Cincinnati, Ohio
BORROR, DONALD J ; *Zoology, Entomology, Ecology, Taxonomy of Odonata,* O. S U., Columbus, Ohio
BRADFIELD, RICHARD; *Chemistry, Botany, Geography,* O S. U , Columbus, Ohio.
CASE, EARL CLARK; *Geography;* University of Cincinnati, Cincinnati, Ohio.
CHRYSLER, HELEN L.; *Botany, Zoology, Geography;* 85 E. Tulane Road, Columbus, Ohio.
CRANE, SISTER MARY MAGDALEN; 2234 Overlook Road, Cleveland, Ohio.
DALEY, E L.; *Geography, Botanical and Biological;* Park Place, Circleville, Ohio.
GOSLIN, ROBERT MARTIN; *Archeology, Zoology,* 804 E. Main St , Lancaster, Ohio.
GRAHAM, GUILBERT R., *Geography;* 1922 Hazel Ave., Zanesville, Ohio.
HEIZER, EDWIN E ; *Zoology, Physiology,* O. S U., Columbus, Ohio.
HESS, EMILY R ; *Botany, Chemistry, Soils,* 141 Mayo Ave., Ft. Thomas, Ky.
HOPKINS, FRANCIS WALTER; *Geography, Geology;* 924 Carlisle St., Martins Ferry, Ohio.
JOHNSON, DOROTHY M.; *Entomology, Botany;* 1608 Neil Ave , Columbus, Ohio.
JONES, FRANCES L.; *Botany, Geology;* 1037 E. McMillan St., Cincinnati, Ohio.
KNULL, JOSEF N.; *Entomology,* 94 E. Oakland Ave., Columbus, Ohio.
LAIRD, WILSON M ; *Geology;* 168 Montgomery Blvd., New Concord, Ohio
LEZIUS, WALTER G.; *Geography, Economics;* University of Toledo, Toledo, Ohio.
LILLICK, LOIS; *Botany;* 6634 Iris, Cincinnati, Ohio.

McALLISTER, ROBT. W., JR.; *Geology, Chemistry;* East Fultonham, Ohio.
PARKER, DOROTHY; *Botany;* 665 Riddle Road, Cincinnati, Ohio.
REMP, MARTIN; *Psychology;* 667 College Ave., Wooster, Ohio.
RICH, JOHN L.; *Geology;* University of Cincinnati, Cincinnati, Ohio
SCHRAMM, MABEL M.; *Entomology, Zoology;* 5115 Fowler Ave., Cleveland, Ohio.
SCUDDER, E. D.; *Chemistry;* Youngstown College, Youngstown, Ohio.
SMITH, FRED Z.; *Geography;* 245 Brevoort Road, Columbus, Ohio
SUTTON, T. SCOTT; *Organic and Bio-chemistry, Animal Nutrition;* O. S U., Columbus, Ohio.

Respectfully submitted,
D. M. DELONG, *Chairman*,
R. B. GORDON,
ALPHEUS W. SMITH.

Report of the Nominating Committee

COLUMBUS, OHIO, March 31, 1934.

To the Ohio Academy of Science:

The Committee on Nominations has the honor to submit the following:

President—JAMES P. PORTER.

Vice-Presidents:

A. *Zoology*—ROBERT S. MCEWEN.
B. *Botany*—O. L. INMAN.
C. *Geology*—WILLARD BERRY.
D. *Medical Sciences*—J. B BROWN
E *Psychology*—FRANCIS N MAXFIELD.
F. *Physics and Astronomy*—C. E HOWE.
G. *Geography*—G. W. CONREY.
H. *Chemistry*—CLYDE S ADAMS.

Secretary—WILLIAM H. ALEXANDER.

Treasurer—A. E. WALLER.

Elective Members, Executive Committee—E LUCY BRAUN,* WM LLOYD EVANS *

Trustee, Research Fund—GEORGE D. HUBBARD.

Publications Committee—F. H. KRECKER, Chairman, J E. CARMAN AND S. R. WILLIAMS.

Library Committee—L. B. WALTON.

Committee on State Parks and Conservation—E S. THOMAS, Chairman; HERBERT OSBORN AND W. E STOUT.

Joint Administrative Board, Ohio Journal of Science—C. G. SHATZER.

Representative Council A. A. A S. and Academy Conference—HERBERT OSBORN.

Respectfully submitted,
WALTER C. KRAATZ, *Chairman*,
BERNARD S. MEYER,
CARL VER STEEG (G. D H.),
H. E. BURTT,
GEO. D. HUBBARD,
WM. LLOYD EVANS,
(Two members absent).

*Vice R. A. Budington and N. M. Fenneman, declined. Elected by Executive Committee.

Report of the Committee on Necrology

To the Ohio Academy of Science:

The Committee on Necrology respectfully submits the following reports on five deceased members and asks that the material in each case be published over the name of the persons furnishing the material.

Respectfully submitted,

FREDERICK C. BLAKE,
J ERNEST CARMAN,
Committee.

ALBERT MARTIN BLEILE

The death of Albert Martin Bleile, which occurred August 16, 1933, brought to a close the career of one of the pioneer physiologists of this country and in his passing the Ohio Academy of Science loses one of its outstanding members.

Dr Bleile was born at Columbus, Ohio, on June 26, 1856, and at the age of twenty received the degree of Doctor of Medicine from Starling Medical College He spent the three years following his graduation studying in Vienna, Paris and Leipzig. It was during this period that Dr Bleile became a student of the eminent Carl Ludwig, a teacher whom biologists recognize as one of the outstanding figures in their science, and undoubtedly it was his association with Ludwig that led Dr. Bleile into the field of physiology for his life's work.

Upon his return to the United States, Dr. Bleile was appointed Lecturer in Experimental Physiology at Starling Medical College and thus became the director of the third experimental laboratory to be established in the field of physiology in the United States, its only predecessors being that at Harvard under the supervision of Bowditch and that at Johns Hopkins directed by H. Newell Martin. For the next eleven years, Dr. Bleile combined the duties of teacher of physiology with those of a practising physician, but when in 1891 he was proffered the chair of physiology at Ohio State University he gladly abandoned his medical practice to accept the position and devote his entire time to the science in which he was so deeply interested.

While preferring to be known and admired as a teacher rather than as a research worker, nevertheless as the result of his experimental investigations, Dr. Bleile contributed many salient facts of fundamental importance to the science he loved. Following his first published research on blood sugar, in 1897, his contributions on causation of epilepsy, cause of death by electric shock, analysis of heart sounds, problems in digestion, vagus action upon the heart, detection of blood, and disinfection all served to illustrate the multiple interests that engaged his attention.

Dr. Bleile was a member of many scientific and civic organizations, retaining his membership even after physical handicaps made it impossible to attend and participate in their meetings and discussions. As a member of the American Microscopical Society from its first

inception he watched it develop from a mere handful of enthusiasts to a national organization. Likewise during his more than half century of interest in science he heartily joined with and enthusiastically supported the American Association for the Advancement of Science, the American Physiological Society, the American Medical Association, the Association of University Professors, and other similar groups having as their aim the promotion and development of learning He no less heartily gave his time and devotion to the more local associations, such as the Biology Club, Columbus Academy of Medicine, the Ohio State Academy of Science and others that have added their contributions to the field of science R. C. SEYMOUR

FRANCIS LEROY LANDACRE

It is an irretrievable loss to suffer the passing of a man who, by virtue of sound judgment, outstanding scholarship, unquestioned integrity and matured wisdom, was recognized and respected as a leader and a champion of any cause in harmony with his ideals. To none other is this more applicable than to Professor Landacre whose death occurred August 23, 1933, after a long illness

Francis Leroy Landacre was born in Hilliards, Ohio, February 13, 1867 His early college days were spent at the Ohio Wesleyan University, transferring later to the Ohio State University from which he graduated in 1895. In 1914 he was awarded the degree of Doctor of Philosophy from the University of Chicago

His academic career as an assistant in the Department of Zoology began immediately following his graduation from the Ohio State University At the same time he was appointed lecturer on Embryology in the old Ohio Medical University and for several years he carried this double load of teaching. In 1902 he became professor of histology and embryology in the Ohio Medical College, and in 1908 professor of zoology and embryology in the Ohio State University In 1914 when the Ohio Medical University became a part of the Ohio State University, he was appointed professor of anatomy and chairman of the department. During his early career, he spent considerable time in residence at the Marine Biological Laboratory at Wood's Hole and also in later years, summers of 1924–1927 as visiting professor at the University of California

Early in his career he came in contact with Dr. C. Judson Herrick, first at Denison University and again later, during his residence at the University of Chicago. It was this association and his contact with Dr. George E. Coghill that afforded inspiration and moreover greatly influenced his course of investigation

In 1901, his first scientific publication appeared and continued at yearly intervals until 1933 His outstanding original achievement was an embryological analysis of the ganglia of the cranial nerves. This work was exceedingly important and its fundamental significance has been emphasized in detail by Dr. Herrick in a scholarly article which appeared in the Journal of Comparative Neurology December, 1933.

From the teaching point of view Professor Landacre throughout his academic career was vitally interested in Medical Education and with the problems concerning the pre-medical curriculum to which he gave broad vision and executive ability.

The following quotation from a previous sketch is well stated and is therefore included here. "As a colleague in counsel, in faculty or in committee, he never voiced an opinion until he had given his best thought to a careful analysis of the subject under discussion, and had found some fundamental principle upon which to base his judgment. He never spoke casually to a question nor in haste. Having thought his way through a problem he was tenacious of his position, for he was too honest to yield on grounds other than a genuine revision of his judgment. His opinions always commanded respect even when he was in the minority."

In 1904 Professor Landacre was secretary of the Ohio Academy, in 1916 he was vice-president of the medical section and in 1918 he was president of the Academy.

In 1901, he married Frances Yeazell, and to them two daughters were born, Anita, now in the Department of Fine Arts, Ohio State University, and Elizabeth, now Mrs. F. W. Matthay, of Janesville, Wisconsin.

Dr. Landacre was an outstanding investigator and a great teacher, and his death is an irreparable loss to the community and University. We miss him from his accustomed place, but are thankful for having had the privilege of his association. R. C. BAKER.

ERNEST SCOTT*

In 1790 Andrew Scott, of Scotch-Irish nationality, emigrated to America. John Scott, his son, born in Ireland, accompanied his father. The Scotts settled in southeastern Ohio, and Alexander Scott, a son of John, was born in Zanesville, Ohio, in 1808. William Henry Scott, the son of Alexander Scott, was born September 14, 1840.

The early years of William Henry Scott were spent amid surroundings and under conditions which characterized life in the Mid-West during the first half of the nineteenth century. William Henry Scott moved to Athens, Ohio, in 1859, and subsequently became Professor of Greek and of Philosophy, and later President of Ohio University, and eventually Professor of Philosophy and President of Ohio State University. Ernest Scott, a son of William Henry Scott, was born in Athens, Ohio, in 1875. He was one of six children.

The pre-school years of life largely determine the character of an individual in future years. Meticulous home tutoring, a deeply religious environment, and frequent contact with pedagogues, together with inherent ability and close association with his father, a scholar and a teacher, undoubtedly had a profound effect upon his later life. He received the Degree of B. Sc. at Ohio State University in 1897. Entering Ohio Medical University, one of the predecessors of the present College of Medicine, he obtained his degree of M.D. in 1900.

*Read at the memorial service of the College of Medicine, May 25, 1934.

I first met Ernest Scott in 1899, when he was a student in the bacteriological laboratory of the Ohio Medical University. Little did I suspect that I was to be intimately associated with this young man for thirty years in medical teaching, more than twenty years of which were served in the same department, and during which time we were in almost daily contact. I found him a man of good taste, using excellent judgment in the choice of his books and friends and cultural objects.

He was a quiet, unassuming, diligent, and intelligent student, deeply interested in all branches of medicine but particularly in bacteriology and pathology. He went cheerfully, almost boldly, through his medical college life, head erect and shoulders thrown back, willing, even anxious, to transform his opportunities into success. He was the possessor of a physical hardihood far above the average. After his graduation he served as assistant physician at Columbus State Hospital for a short period.

Germany and Austria in their days of medical glory beckoned the American student. In 1901–1902 Dr. Scott did graduate work at the Universities of Freidburg, Germany and Vienna, Austria. Later he attended the University of Chicago and the Harvard Medical School. In the fall of 1903 he began his teaching career as Instructor of Histology at Ohio Medical University, and in 1904 became Professor of Pathology at that institution, retaining this position in Starling-Ohio Medical College after the union of the two independent medical schools. During this time, 1910–1914, he also taught Veterinary Pathology at the Ohio State University. When the Starling-Ohio Medical College was taken over by the Ohio State University in 1914, becoming the College of Medicine of Ohio State University, Dr. Scott was retained as Professor of Pathology and was also appointed chairman of the department, which positions he held until the time of his death in 1934.

During these years of activity as a teacher of Pathology at Ohio State University, he was active in many other allied fields, serving as bacteriologist to the Columbus Board of Health in 1904–1905, and pathologist for the University, St. Francis, White Cross and Children's Hospitals.

He knew that the thoughts and hopes of the medical profession of this nation are centered in progress obtained by careful research, and he did not allow the needs of the hour to warp his vision of duty to the future. In addition to the above named activities he also found time for research, and since 1914 published upward of forty medical papers covering a wide range of subjects. The following lines of investigation were of special interest.

A method for the celloidin injection of the circulatory systems of the kidney and heart.

The preparation and use of the medical museum.

A determination of the non-injurious effects of the ingestion of aluminum salts upon the growth, reproduction, and blood picture of the white rat.

A determination of the non-injurious effects of the ingestion of tartrate or sodium sulfate baking powders upon the growth, reproduction, and kidney structure of the rat.

The degenerative effect on parenchymal tissues, neurones, and retina in monkeys, rabbits, and rats from the administration of methyl alcohol.

Encephalitis and parkinsonism.

Tumors of the central nervous system.

Tumors of the sympathetic nervous system and the adrenal medulla.

Hypophyseal tumors

A study of the effect of feeding irradiated milk to rats with experimentally produced nutritional anemia.

A study of the influence of the feed of cows upon the nutritional value of their milk, in which it was found that adequate plant pigments in the diet of the cow produce milk which will prevent nutritional anemia.

Modern civilization, with its crowding together of vast numbers of persons under unusual living conditions, introduces not only new pleasures but also new hazards to human health and to human life. The battle of scientific medicine against these hazards is the problem of the modern investigator. The modern scientist's energy has no borders; it is a shapeless mass of force leading onward and onward. Dr. Scott, once having become interested in the problem of milk, attacked this problem from various angles. He was interested in the effects of cattle feeding and pasteurization on the food value of milk and carried on experiments constantly in this field, and even at this time we have more than two hundred rats in the laboratory on which experiments in nutritional anemia are being conducted. During the last ten years Dr Scott also became interested in neuropathology and wrote a number of papers on this subject.

A university cannot undertake to give a student character or intellectual interest, the student must have these qualities when he enrolls. The work of the university begins where the work of the parents leaves off. If the student does not possess these requirements before he enters the College of Medicine, he is badly handicapped. Therefore the College of Medicine some years ago inaugurated a plan of personal contact with prospective pre-medical students, requiring a personal interview with each applicant. From 1928 to 1934 Dr. Scott was a member of the Entrance Board, assisting Mr Stradley in investigating the applications and interviewing the applicants for admission to the College of Medicine. How well he served in this capacity can be best expressed by Mr Stradley himself.

"It is difficult to adequately pay tribute to the memory of Dr. Ernest Scott His was a quiet yet forceful personality—the kind of personality that grew into the heart as one learned to know him well. Perhaps his outstanding characteristic was a generous interest in the welfare and happiness of those about him. In coming into his presence one felt at once that here was one to trust, to depend on, one whose decisions would be just and kindly. A strong man—his resistance was lowered by devoted and persistent service to his college and to his work.

Dr. Scott was a member of the Entrance Board and for several years he had been of invaluable assistance to the University Examiner

in the selection of students for the College of Medicine. Restricted selection is especially difficult when there are large numbers of applicants with a high average scholastic rating practically all of whom are potentially prepared for study in their chosen field Selective techniques should evolve in the light of the aims and objectives of the college. He never lost sight of the standards of his college in his advisory capacity as a member of the Entrance Board but at the same time he was sincerely sympathetic with the ambitions and hopes of the young men and women so eagerly seeking admission.

His modest simplicity, personal greatness and conscientious efforts to his profession and to the University were the traits which made his life so meangingful and rich in achievement "

The avowed purpose of education is the preparation of the individual to meet life's problems It embraces more than the mere ability to earn the daily bread. It is not merely utilitarian in purpose He must appreciate the arts and sciences, and if possible, add something to them. Students have dreams of striving for high ideals and achieving great things If properly encouraged to persevere, they will later in life realize that the progress of civilization is dependent not so much on the deeds of a few great geniuses, as on the contributions made by the multitude of lesser lights Dr Scott was ever ready to talk to students about their problems, never in a hurry, a willing listener, he tried to help young students to discover or make opportunities for themselves rather than advising them, and while he was rigid in his requirements, he was always accessible and responsive to student problems. He so loved his subject that he made his students realize its importance.

The rise in the number of deaths from angina and coronary thrombosis is believed by many physicians to be associated with the tremendous speed and strain of modern life, which throws an immense burden on the nervous mechanism and on the heart. The years of man according to biblical legend are three score years and ten, but it is remarkable how much can be accomplished in a shorter life

Hailed as the most successful alumni event in the history of the University, the hundredth anniversary celebration of the College of Medicine, March 1, 2, and 3, 1934, was regarded in campus circles as one of the crowning achievements of Dr. Scott's career. For many months prior to this celebration, which was attended by more than one thousand graduates, Dr Scott labored incessantly in organizing the alumni, urging them to attend the celebration, collecting specimens, arranging a program of clinics, lectures, and demonstrations. He was tireless in his efforts. Monday, March 5, he returned to Hamilton Hall, and with Dr. Rightmire, made a tour of the exhibits, and at luncheon at the Faculty Club he told Mr. Eckelberry, "We'd live a lot longer if we took it easier." That afternoon in his office he admitted that he was a little tired, but remarked that the centennial was a glorious celebration, and hoped that the medical center might become a reality.

He succumbed finally to speed's tyranny, perhaps not realizing that the white-hot, nerve-racking, life-burdening pace that he had been

going demanded more of the body than it can give if it is to remain healthy. Wherever man lives there is also grief. That night Dr. Scott died of a heart attack which seized him as he slept, and his death was a sad shock to his numerous friends and a great loss to the College of Medicine, for in his entire career he had never brought disrepute upon his guild.

A few days later we followed his earthly remains along the grass-lined road, past the beautiful wooded land he loved so well, over the paved roads and back to the city. Up the path into the church they carried him, where his friends and colleagues were waiting, and no more splendid tribute could be paid to any man than those that were there voiced by the President of the University in his brief but forceful summary of the life of our departed friend.

POSITIONS HELD BY ERNEST SCOTT, M D.

1. Assistant Physician, Columbus State Hospital, 1900–1901.
2. Bacteriologist, Columbus Board of Health, 1904–1905.
3. Professor of Histology, Ohio Medical University, 1903–1904.
4. Professor of Pathology, Ohio Medical University, 1904–1907.
5. Professor of Pathology, Starling-Ohio Medical College, 1907–1913.
6. Assistant Professor of Veterinary Pathology, Ohio State University, 1910–1914.
7. Professor of Pathology, Chairman of Department, Ohio State University, 1914-1934
8. Secretary of College of Medicine, Ohio State University, 1933–1934
9. Member of Entrance Board, Ohio State University, 1928–1934.
10. Pathologist for University Hospital, 1906–1934.
11. Pathologist for St Francis Hospital, 1908–1934
12. Pathologist for White Cross Hospital, 1922–1928.
13. Consulting Pathologist for White Cross Hospital, 1928–1934.
14. Consulting Pathologist for Children's Hospital, 1918–1934.
15. Consulting Pathologist for Columbus State Hospital, 1928–1934
16. Consulting Pathologist for State Industrial Commission, 1924–1934

SOCIETY MEMBERSHIPS

Sigma Xi—Honorary Scientific
Alpha Omega Alpha—Honorary Medical (Faculty Advisor)
American Medical Association.
Ohio State Medical Association.
Columbus Academy of Medicine
American Society of Clinical Pathologists
Ohio Society of Clinical and Laboratory Diagnosis.
American Association of Pathologists and Bacteriologists.
American Association for Cancer Research.
International Association of Medical Museums.
Ohio State University Association.
Ohio Academy of Science.

C. L. SPOHR, M. D.

GEORGE B. TWITCHELL
1865–1933

On April 28, 1933, Dr. George B. Twitchell died of the after effects of an operation. A week earlier I was with him in his study. He was winding up his personal affairs with the same philosophical, calm and deep-rooted humor which had always characterized him. He showed me a manuscript which he had just finished. Little would be needed to get it ready for publication, he said, should he not return.

Its title reads: "Urnatella gracilis, a living Trepostomatons Bryozoan." It represents a second major contribution which Paleozoology has received from him. It sheds light on the zoological affinities of an important group of extinct Bryozoa.

Three years before, he had done a similar service by bringing compelling proof that a curious group of large and widespread fossils, the so-called "true" Stromatoporoids, represent the remains of an extinct group of marine sponges.

To have produced one of these papers would be sufficient to give deep satisfaction to a professional paleontologist. Yet the study of fossil and living bryozoans and sponges was only an avocation with Dr. Twitchell.

He was born in 1865, in Cincinnati, the son of an optician who had a deep love for nature and took the boy on long walks and instilled in him a lasting interest in nature. After completing Woodward High School, he had to go to work but studied assiduously on the side and, when he was not yet 21 years of age, he published an interesting paper on the life found in the Tyler Davidson Fountain on Fountain Square, Cincinnati. He entered Miami Medical College to study medicine, and graduated in 1890 After hospital service as extern and intern in the City Hospital, he took up an independent practice in Cincinnati.

As soon as his duties permitted, he resumed his favorite tramps along streams and ponds and his studies of freshwater bryozoa and sponges. It was but natural that his interest should extend from the living to the fossil bryozoa so abundant in the rocks at Cincinnati, and he began building up a large collection of fossil material, grinding with his own hands thousands of thin sections of bryozoa. Soon his opinion was sought by outstanding workers in this field of Paleontology. He was elected a member of the Paleontological Society of North America. He joined the Ohio Academy of Science in 1929 and presented several papers before the Geology section.

Dr. Twitchell bequeathed to the Department of Geology of the University of Cincinnati his valuable collections of specimens and microscopic slides, which constitute a worthy monument to the memory of this unusually gifted observer and enthusiastic student of nature.

WALTER H. BUCHER.

FRANK ROBERTSON VAN HORN
1872–1933

On the first of August, 1933, Frank Robertson Van Horn died in his sixty-second year. He had been a life member of the Academy since 1921 and a Fellow since 1922. His entire professional life, after taking his doctor's degree at Heidelberg in 1897, was devoted to the Case School of Applied Science in Cleveland.

Van Horn seldom attended the Academy meetings, but the geologists of Ohio will long remember his presence at national meetings, for he was secretary to the Mineralogical Society of America from 1922 and on the council of the Geological Society of America from 1931 onward.

The undergraduate college world of Ohio knew him best from 1900 to 1925 as the faculty manager of Case School athletics, in which position he won and held the confidence and allegiance of students and alumni to a degree seldom permitted to one in the ranks of professorship, or, indeed, in any rank. Each and all knew him as "the Count" and respectfully addressed him by the title.

He wrote some 26 papers, mostly on mineralogical subjects, all sound, complete and enduring records which prove his taste and ability for research, but living, to him, was opportunity to serve his students and fellow workers and there was little time left for himself.

In all he undertook, Van Horn was a keen, tactful judge of men, shrewed in human affairs, thrifty in business matters, methodical to the last degree, hearty and bluff He was a man of service to his fellow men.

J. E. HYDE.

Report of the Resolutions Committee

COLUMBUS, OHIO, March 31, 1934.

THE OHIO ACADEMY OF SCIENCE hereby expresses to the President and other administrative officers of the Ohio State University, including also the staff of the Ohio Archaeological and Historical Museum, and to the members of the local committee its grateful thanks for the hearty and cordial welcome received by its membership and guests, at its forty-fourth annual meeting.

Respectfully submitted,

D. F. MILLER,
G D. HUBBARD,
(G. W. CONREY)

Letter to Senator Fess

(Prepared by Dr. A E. Waller)

Hon Simeon Fess, United States Senator, Washington, D C

DEAR SIR.—The *Ohio Academy of Science*, composed of 450 representatives of science in its various branches wishes to be placed on record as protesting the present abuses of the National Botanical Garden. In attempting to remedy these, it suggests a change of policy in the arrangement of the garden A staff of scientifically trained men qualified to direct and maintain a great garden adequate to function as a center of botanical research and study is suggested

Your attention is respectfully invited to the following resolution unanimously adopted by the Academy at its 44th Annual Meeting in Columbus, March 30 and 31, 1934.

> "WHEREAS The institution known as the National Botanical Garden is unfavorably known for its abuses of the high purposes for which it was founded,
>
> "*Therefore Be It Resolved*, That the management of it be composed of scientifically trained men, who will endeavor to fulfill the aims and purposes of botanical research."

PRESIDENTIAL ADDRESS

A HISTORY OF OHIO'S VEGETATION

E LUCY BRAUN

We are accustomed to think of history in terms of what man has done, or perhaps, in terms of the great events of the building of the world- earth history. Probably few, however, connect history with plants. Yet we can trace the vegetational history of our state through long periods of geological time. To do this we must gather evidence from fields outside the realm of botany, going in turn to geology, soil science, meteorology, and at times to physics and chemistry.

As with records of human activity, the earliest vegetational history is extremely hazy. In fact we cannot even surmise what may have been the nature of the plant cover of the first land of the state to emerge from the Paleozoic seas—except that we know it must have been extremely primitive. Later, in the shales of Devonian and Carboniferous times, definite records are preserved for us of a flora of increasing complexity but still profoundly unlike that of today. But it is not of these ancient floras that I wish to speak. We shall pass over these early records and see what happened next. Through a long interval of time, records are absent. We build our skeleton of events from the known happenings on other land areas of North America. The forerunners of our modern vegetation have arisen; gradually they increase in number and variety and in area occupied, until in Tertiary time, forests of present day aspect and with many of the species of today covered the land.

To this point our history is built for the most part on fossil evidence. Later history must be reconstructed largely from the pattern of existing vegetation, though certain types of fossil evidence will still be utilized, and soil types will give us clues.

Toward the close of Tertiary time let us picture Ohio—or the land that is now called by that name: Clothed with deciduous forest whose species were many of them plants ranging over vast territory- even over Europe and Asia, encircling the globe in temperate latitudes. Far to the north

were belts of unlike vegetation, much as there are today—belts of evergreen forest, of stunted and dwarfed trees and shrubs, and tundra and arctic wastes.

Then a great cataclysm occurred, upsetting the established equilibrium of ages, creating tensions so great that whole masses of vegetation were set on the march. Far up in the north, in the Hudson Bay region, snow and ice were accumulating, forming the nucleus of a great glacial advance which was to overwhelm the northern half of the country. As the ice sheet grew and slowly advanced southward, temperature and moisture conditions were greatly modified along the ice edge. Slowly the vegetation retreated southward under the pressure of climatic change Many constituents of the retreating vegetation were overtaken and annihilated: how many we can never know. But a goodly number escaped, many of which are here today.

At the time of maximum extent of the continental ice sheets of North America, much of Ohio was buried under hundreds of feet of ice In the western part of the state where the southward advance was greatest, the ice margin was at one time south of the position of Cincinnati. Not once, but several times, did such ice advances take place and between each glacial advance were long warm interglacial periods when the ice retreated far to the north or disappeared entirely from continental North America Each of the several advances which came in this direction left mantles of glacial drift whose margins are clearly discernible and which tell us just how far the ice retreated. A survey of a glacial map will show us that the land surfaces of Ohio are not all of the same age. The southeastern quarter of the state is unglaciated, and hence very old; the remainder, or glaciated part of the state is much younger. In this glaciated part we may recognize three sections: First is a strip in the east-central part of the state, expanding southwestward, which is covered by glacial deposits left by one of the older ice advances, the Illinoian. Second, the great central band which stretches from the northeast counties westward and southwestward is of Wisconsin age and records the last glacial advance. In the region of the Miami and upper Little Miami valleys, are deposits of slightly earlier age, the Early Wisconsin. Third are the lake plains in the northwestern part of the state, formed by the forerunner of Lake Erie, the glacial Lake Maumee of the close of the

Pleistocene. The pattern on the map may be thought of as produced by a series of superimposed deposits, the lower and older projecting somewhat beyond the upper and younger, arranged much as are the shingles on a roof For each of these regions the vegetational history is distinctly different, and in none is the vegetation static; changes are still in progress.

In the unglaciated section, the vegetation covering has been continuous from Tertiary time throughout the Pleistocene or glacial epoch to the present In the glaciated section all vegetation was wiped out by the ice, and the vegetation of this, the greater part of Ohio, has entered since the melting of the ice in a series of migratory waves of unlike kind Its vegetation is comparatively young.

Returning now to the unglaciated southeastern section of Ohio, let us pick up the threads of our history in the forests of Tertiary time, deciduous forests of the sort we know today. Though no part of unglaciated Ohio is more than 60 or 70 miles beyond the glacial boundary, we may say on the basis of botanical evidence that its vegetation was not profoundly affected by the ice sheets Doubtless, narrow strips of arctic tundra and boreal forest bordered the ice margin; then beyond was undisturbed deciduous forest. Could this be possible in the proximity of continental glaciers? We believe so The phenomenon of glaciation may be brought about without extreme refrigeration, even at the center of ice accumulation A lowering of average temperatures 5 to 7 degrees Fahrenheit, together with certain precipitation changes might be enough to bring on another glacial advance. At the limit of ice advance, melting exceeds onward movement, that is, the position of the ice margin is determined by the warmth of the climate, not by its coldness If we look at the narrow coastal strip of Greenland, extending only about 40 miles out from under an ice cap thousands of feet thick, we find a vascular flora made up of approximately 400 species in 50 families—and this at latitudes between 60 and 80 degrees, and bathed by cold polar seas [1] Ohio has 2300 species (including several hundred recent introductions) which is less than six times the number of Greenland's flora To be sure, the flora of Greenland is Arctic, but no more so than at the same latitudes of continental North America far removed from ice caps. In Alaska, forests

[1]Eckblaw, W. Elmer In "Naturalist's Guide to the Americas." Williams and Wilkins, Baltimore. 1926.

are growing in the accumulated detritus on top of glaciers. In Alberta, some of the muskegs are permanently frozen at depths of two feet, yet there is abundant vegetation including spruce-fir forests[2]. So even where conditions are much more extreme than there is any reason to believe they were at any time in southeastern Ohio during the Pleistocene, there are forests.

I have digressed from the recounting of the sequence of events in Ohio for so often the belief is voiced that the refrigeration of climate must have extended for hundreds of miles beyond the ice front. Yet existing evidence strongly contradicts this belief. Also, the acceptance of the premise that temperature effects were not pronounced beyond the ice margin is necessary for the continuance of our historical framework.

The southeastern part of the state supports, or did before the white man entered, forests closely comparable to those of Kentucky and West Virginia to the south; forests of mixed composition containing a fair proportion of distinctly southern species, a number of which find the limits of their range in this area or do not extend far beyond it. In the thousands of years since glaciation they have advanced but little.

At some time early in the Pleistocene—earlier than the date of the first advance of ice of which we have record in Ohio—the humid climate which had prevailed for so long changed and drier conditions ensued, especially in the north-central states. This was a climate more suitable to grassland development, and the grasslands of the West moved eastward and southeastward into southern Ohio, into what is now Adams county. Remnants of this vegetation still persist in Adams County. The position of these remnants on or near pre-Illinoian divides, and the composition of communities tell us much about these oldest Ohio prairies, and give us a clue to their age.[3] This xerothermic period was terminated by the advance of the Illinoian ice sheet, the oldest and most extensive ice sheet of which we have record in Ohio. With the advancing ice which overwhelmed most of this great prairie lobe, northern vegetation moved southward, crowded into a narrow strip on and near the ice margin. The arbor

[2]Lewis, Francis J. and E. S. Dowding. The vegetation and retrogressive changes of peat areas ("muskegs") in central Alberta Jour. Ecol. 14: 315–341. 1926.

[3]Braun, E. Lucy. Glacial and post-glacial plant migrations indicated by relic colonies of southern Ohio. Ecol. 9: 284–302 1928.

vitae, hemlock, white pine and yew, and many other plants, established themselves in favorable situations. A few of them still remain, scattered groups of individual species or relic boreal colonies[4] They tell us of the period of invasion by this type of vegetation. Their geographic distribution, clearly shown by maps giving county records of occurrence, shows that they are almost limited to the marginal band of the unglaciated section[5]. Since the close of glaciation southeastern Ohio has been enriched by the addition of southern plants which are still spreading northward.

Let us turn now to the great glaciated area of Ohio. Instead of a vegetational cover of great antiquity, here is one which started anew on the great wastes of ground up rock material— drift—left by the glaciers. Instead of soils prepared through the ages for occupancy by plants, here was raw material, not soil, unweathered, unfertilized by humus, unsuitable to any but pioneers which could endure the poor soil, the exposure, the excess of water left in depressions or the barrenness of cliffs or polished rock surfaces

Not once, but many times, the glaciers advanced. So we have not to trace a single sequence but a complex series of advances and retreats, of north and south waves of migration, modified or even interrupted by lateral movements. The oldest glaciated area in Ohio, the southern portion which is covered by drift of Illinoian age, was first populated about four-hundred thousand years ago. The moderating climate was quite humid and plants requiring a large amount of soil water found a favorable environment. The events which followed are obscure. We may surmise that they were similar with certain exceptions to those which we know occurred on the youngest drift area. The history of the last few thousand years is clearly outlined by certain vegetational developments observable today. These I shall consider as a part of the recent history of Ohio's vegetation. But before we are ready for this, let us examine the youngest glacial areas of the state.

Here has been an uninterrupted development since the final retreat of the ice. Each step is outlined by the nature of relic communities and the inter-relations of communities. And

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[4]Braun, E. Lucy. The vegetation of the Mineral Springs region of Adams County, Ohio. Ohio Biol Surv. Bull. 15. 1928

[5]Transeau, E. N. and P. E. Williams. Distribution maps of certain plants in Ohio. Ohio Biol Surv. Bull. 20. 1929.

even more positively, perhaps, is the story told in the fossil pollen preserved in the bogs of northern Ohio.

Let us picture the gradual retreat of the ice, which everywhere leaves behind it an irregular mantle of drift. Depressions are filled with water from the melting ice, hummocks are dry or moist depending on their size and the frequency of rains. Plants of many kinds are growing in the detritus on the ice margin and on the older land adjacent to that being uncovered. From these plant seeds are carried by wind and other agencies into the barren land. The arctic tundra of the ice margin retreats northward following closely the melting ice Bog plants such as Sphagnum, cotton grass and sedges of the Arctic established themselves in and around the pools. and we can picture scenes much like those to be found in comparable areas today. The ice retreated farther and farther; the plants of boreal or northern coniferous forest crowded into the tundra. Spruce and fir trees, at first dwarf and subarctic in appearance, later forming true Canadian forests, appeared. These probably at one time occupied much of the central and northern part of the state, enclosing the ponds and bogs, which by now were surrounded by belts of bog shrubs and larch and arbor vitae In the western part of the state, perhaps even elsewhere, the occupancy by spruce and fir may never have been complete

Almost concurrently with the warming of climate, rainfall decreased. Prairie began to advance from the west, and many a prairie plant found suitable environment in the still unforested glacial plain, or along the open bog borders wherever these were dried by the lowering water table. Where spruce-fir forest had been established, it began to thin out and other trees more suitable to the drier climate entered. For a time, then, pine forests held sway in certain sections But the dominancy of evergreen forests could not continue long under the pressure of advancing southern deciduous trees. Oaks and hickories began to mix with the pines. An increase in the humidity of climate made it possible for the deciduous forest to invade some of the prairie areas, as well as to replace the pine forests Deciduous forests of mixed aspect were established—forests essentially like those of today.

Changes have taken place since in the composition of the forest, paralleling climatic shifts from dry to moist and back again. Records indicate two dry and two moist periods in post-glacial time.

Some among you may be wondering what is the basis for this fabrication, how authentic it is, or whether it is just a story constructed on probability.

For evidence let us look at any one of the bogs of Ohio. In Champaign County, for instance, is one[6] in which may be found a number of northern plants—a relic colony far removed from other vegetation of its kind and reminiscent of conditions long since passed How did the plants get there? Not by a jump of hundreds of miles from present day northern bogs, but during the methodical northward retreat of these plants along the retreating ice front. Why do they stay? Because the more southern deciduous forest vegetation is not suited to these habitat conditions, and hence the stress of competition does not kill out the survivors of an earlier vegetation. While the typical zonation in the bog displays open sedge areas, shrub border, arbor vitae or white cedar forest and lastly, deciduous forest, there are departures from this sequence. This same bog area gives abundant evidence of the eastward spread of grassland species Many of these are found in the drier open parts, where the sequence passes from bog to prairie and then to deciduous trees. Wherever the conifer forest border had not become established prior to the dry climate period, prairie vegetation entered There were many such spots and some of them from which all vestige of natural vegetation is gone may still be identified by the soil. Anyone following one of the main highways southwestward from Columbus cannot fail to see these black soil areas.

Instead of floristic evidence, some may prefer to rely on fossil evidence. We have it, too, in some of our bogs. The work of Dr. Sears[7] on pollen analysis of bogs demonstrates the early occupancy of a spruce-fir forest, its gradual supplanting by a pine forest or by pine and oak forests, and the final replacement of these by wholly deciduous forests.

In all probability the progression of events was greatly slowed down in the northern part of the state, and the period of occupancy by spruce-fir forest greatly lengthened This was due in part to the more northerly latitude and in part to

[6]Markle, M. S The phytecology of peat bogs near Richmond, Indiana. Proc. Ind Acad. Sci., 1915, 259–375.

[7]Sears, Paul B A record of post-glacial climate in northern Ohio Ohio Jour. Sci. 30. 205–217 1930

Sears, Paul B Pollen analysis of Mud Lake Bog in northern Ohio Ecol 12: 605–655. 1931

the proximity of the large glacial lake occupying the Lake Erie basin. This lake was fed by melting ice, hence it was constantly at a low temperature. This, together with the more northern latitude conspired to hold off deciduous invasion until relatively recent time

When the ice nearly receded from the last of the Great Lakes, Lake Ontario, and the St. Lawrence valley was still ice-covered, a Mohawk-Hudson outlet to the sea was established. Later, toward the close of glaciation and many thousand years after the ice had left Ohio, an encroachment of the sea extended up the St. Lawrence valley into Lake Ontario and Lake Champlain The Champlain-Hudson River valley became a salt water strait[8]. The Great Lakes everywhere were receding, reaching nearly the outlines of today. Long stretches of sandy lake shore and the lake plains of northwestern Ohio were exposed. Into this new land invaders came, invaders from the adjacent forest to the south, from the extended prairies to the west, and from the Atlantic region to the east. The invasions from both east and west are clearly shown by the plants growing in the lake region today. Many western zerophytes, some of which are not found in the central prairie counties, occur. And such Atlantic coast species as the sea rocket and seaside spurge are at home along Lake Erie.

The glaciers have gone from the continent of North America. As far as can be ascertained from weather records, climate is not changing. Yet our vegetation is not static, but constantly changing. The thirty thousand years, more or less, which have elapsed since the ice finally disappeared from our state has not been long enough to permit a complete adjustment of vegetation. Development is still in progress. Almost anywhere where natural primary vegetation remains we may see the evidence of change, of the replacement of one community by another, or what ecologists call succession.

Every plant succession is directed by both internal and external factors, and wherever conditions are similar, all pass through the same stages. The entire post-glacial sequence of vegetation has been directed by climatic change, and hence may be considered a climatic plant succession. The relatively recent vegetational history of Ohio is written in the stages of successions which are in progress now, successions directed by

[8]Chamberlin, T. C. and R. D. Salisbury. Geology, Vol. III, Earth History. Henry Holt & Co., New York 1907.

changing topography or the reactions of the vegetation itself. For each different region the lines of development are different, so to trace accurately the history of any section, its successions must be worked out with care and detail. One general trend seems evident everywhere—development is toward the establishment of mixed deciduous forests of the type which have so long held dominance in the southeastern part of the state and have become well established in many places in glaciated southern Ohio.

Vegetational development has fairly well kept pace with physiographic development. Where a mature topography is reached, plant succession has progressed farther. Wherever topography is youthful, successional development lags. This is shown by maps offered by Sears for parts of the north-central counties[9]. My own work in the drift plains of the southwestern counties shows the same relations. This relation of vegetational development to maturity in the erosion cycle is also readily demonstrated by a comparison of the vegetation of glaciated and unglaciated regions.

It is only in areas of youthful topography that we can trace vegetational development uninterrupted by the retrogressive changes initiated by erosion. Vegetational development is in progress everywhere; it is less complicated where caused mainly by the reactions of vegetation itself

Let me trace one such developmental series as an example of the changes now in progress in virgin forest areas of Ohio's vegetation. We shall look at the flat and undissected Illinoian drift plain in southwestern Ohio. The area is a plain in which there are very shallow almost unnoticeable depressions from one to five feet in depth. The soil is fine-grained, compact, impervious. The water table is high, and the larger, and deeper depressions are covered with shallow water for part of the year. Through thousands of years these depressions supported swamp vegetation; many of the plants now growing in them are decidedly northern in distribution, plants persisting here from early post Illinoian time. Trees adapted to the swamp habitat were lacking; sedges and shrubs remained in control. Gradually the water table was lowered, relatively, and pin oak began to invade. An open pin oak forest with sedge ground cover came to occupy the depression. Pin oak

[9]Sears, Paul B. The natural vegetation of Ohio III. Plant succession. Ohio Journ. Sci. 26: 213–231. 1926.

is exceedingly intolerant of shade. It cannot succeed in the shade of other trees. Such open pin oak forests are the first forests to occupy these depressions In the open spaces between the large pin oak trees, the light conditions are still suitable for pin oak, and more enter. This invasion is possible only if the water is not too deep; any pronounced invasion is correlated with temporary lowering of the water table In recent years, this has in places been brought about by ditching, and dense stands of pin oaks have entered in the open spaces in the virgin pin oak forest.

The shade produced by even a partially closed stand of pin oak makes conditions suitable for other tree species White oak, shell-bark hickory and sometimes black oak invade Gradually these trees grow up; the old pin oaks die out and a white oak-hickory or white oak forest is established Shade is increasing, a layer of humus is forming, root competititon is increasing Beech, one of our trees which is most tolerant of shade, enters in the understory. A white oak forest with beech as an understory is the result In such a forest, the white oak trees are several hundred years old The young beech trees are thriving in the shade of the white oaks, and are ready, when old age takes a tree, to replace white oak by beech Not in a single step, but very gradually this change takes place; finally a beech forest is established. If we figure the time necessary to allow for this forest development, we find that 2000 years would not be long enough if each forest type could follow directly on another without transition phases, without the long periods of change which we see going on everywhere. Many times that amount—a hundred thousand years perhaps—has been required for the establishment of the beech forest, the ultimate or climax stage in this succession on the wet flats of Illinoian drift.

This beech forest is the most advanced stage which is possible on the youthful topography persisting here. Only as a more mature topography develops with the dissection of the area by streams can vegetational development go further. Then the mixed forests of southern expression which are climatically possible here may enter.

Through such developmental changes, Ohio's vegetation finally became established A complex mosaic of forests types, interrupted here and there by swamps or prairie openings, by cliffs and sandy beaches, became established. Into this

primeval Ohio, the white man entered, and with him the greatest destruction of natural vegetation of all post-glacial time.

Let me close with a quotation[10]---a description of Ohio's forest in 1834, just one hundred years ago:

"The scenery now, even for the forest, was becoming unusually grand It repeatedly broke away from you, so as to accumulate the objects in the picture, and to furnish all the beauties of light, shade and perspective. The trees, too, were mostly oak, and of finest growth. Their noble stems ran up some hundred feet above you and were beautifully feathered with verdant foliage There they ran off in the distance, park-like, but grander far, in admirable grouping, forming avenues, galleries and recesses, redolent with solemn loveliness; and here, they stood before you like the thousand pillars of one vast imperishable temple for the worship of the Great Invisible. Well might our stout forefathers choose the primitive forests for their sanctuaries All that art has done in our finest Gothic structures is but a poor, poor imitation!"

[10]From "A Stage Coach Journey Across Ohio in 1834," in Howe's "Historical Collections of Ohio"

Cephalaspids.

In the publication of this monograph of the Cephalaspids of Great Britain, Dr. Stensiö has greatly added to the available knowledge of this important and extinct group of primitive vertebrates Supplementing his previous work on the Cephalaspids of Spitzbergen, this study of collections in the museums of England, Scotland and the Continent, but chiefly those of the British Museum, has clarified and amplified our knowledge particularly of the general character and squamation of the trunk, the development of the fins, and the micro-structure of the exoskeleton

A complex network in the superficial parts of the corium of the head, trunk, and pectoral fins, comprising a mucous canal system, opening outwards by means of special pores and constituting either a slime-producing or special sense organ, is seen to occur in all Cephalaspids studied A well-developed paired fin-fold, a homologue of the ventral fins of fishes, is regarded as strengthening Goodrich's fin-fold theory The ventral slit-like mouth resembles that of the Pteraspids. All Cephalaspids are seen to possess ten external branchial openings Cephalaspids are compared with other Ostracoderms, and the phylogeny of the group is discussed. Stensiö makes no attempt to support Patten's theory

More than half the volume is given over to photographic plates, which are remarkable for their clearness The reader is impressed with the author's ability to reconstruct the brain, sense organs, cranial nerves, blood vessels, and electric organs in the head region in these fossils, and depict them in colored plates This volume is an unusually fine example of precise description, and critical analysis, supplemented by the highest type of photographic and printing skill A valuable bibliography is given.—JOHN W PRICE

Cephalaspids of Great Britain, by Erik Andersson Stensiö xiv+220 pp, 66 Pls and 70 Text Figs. British Museum (Nat Hist) London, 1932 Price, Three Pounds.

SOME ERYTHRONEURA OF THE COMES GROUP (HOMOPTERA: CICADELLIDAE)

DOROTHY M. JOHNSON

During a study of the *Erythroneura* of the *Comes* Group, chiefly from Ohio, several undescribed species and varieties were found. An examination of the inner male genitalia of previously described forms indicated in a few cases, need for a change in status.

Types of the species here described are placed in the collections of the Ohio Biological Survey and of Professor Herbert Osborn under whose direction this work was done.

Erythroneura nigroscuta n. sp.

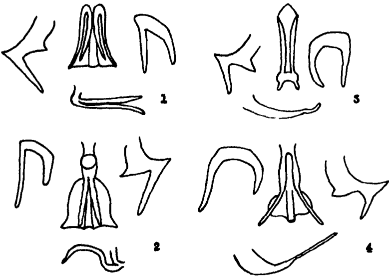
(Fig 1)

Ground color of vertex, pronotum and scutellum yellowish white, of elytra whitish semihyaline, with red to yellow color markings. Vertex, a median inverted U-shaped vitta with lateral extensions to eyes at half its length; pronotum, U-shaped median pellucid vitta with very heavy base, the arms not reaching anterior margin, area between arms and on either side pale, a broad vitta behind either eye, sometimes entire posterior half of pronotum yellow; scutellum, basal angles yellow, median basal area black, apex black, a thin yellow transverse streak between apex and median dark basal part. Elytra: clavus, in basal half an elongate vitta, swollen at tip to meet tegminal suture where it includes a large oval black spot, a spot at apex; corium, an oblique streak near base, another arising before costal plaque, bordering inner margin of plaque to apex, thence to base of cell M_4, area posterior to hyaline plaque washed with color. In some specimens the elytra appear entirely yellow before the apex but for the dark claval spot and hyaline plaque. Crossveins and adjacent part of longitudinal veins agree in color with vittae; hyaline area just posterior to crossveins followed by dusky apices; a large black spot in base of cell M_4 and one in apex of R_3, and irregular black dash at apex of costal plaque. Below creamy white to dirty white, but for dark-tipped ovipositor and dark apices of plates in male. Disc of first three abdominal segments dusky dorsally.

Inner male genitalia: Style, heel slightly less than a right angle, base straight, anterior point a right angle, posterior point one-third longer than base of foot, forming less than a right angle with and rounded to base; oedagus triangular apically, transverse at tip, with pair of double processes, the inner parts parallel and slightly swollen apically, the outer longer, more slender and diverging apically; pygofer hook with points of about equal length.

This species resembles *Erythroneura comes* var *compta* from which it may be distinguished by the different inner male genitalia, the definite black markings of the scutellum and clavus, and the rather indefinite color markings In var *compta* the dark markings are less definite while the color markings are distinct and of the *comes* type

Holotype (male), Kelly's Island, Ohio, July 16 1920, C I Bliss, and two females, allotype and paratype, same data, paratypes, two, Adams Co, Sept 1, 1931, E P Breakey,



Inner Male Genitalia Erythroneura of the Comes Group
1 *Erythroneura nigroscuta* n sp 3 *Erythroneura vaga* n sp
2 *Erythroneura attenuata* n sp 4 *Erythroneura bistrata* McAtee

on *Vitis* and *Malus*, one, Rock House, Hocking Co Sept 17, 1933, D M Johnson, and other specimens from Ohio—Adams Co, Sept 1, 1931, E P Breaky, *Vitis*, Columbus March 3, 1901, H Osborn, Ashley, August 1, 1920, Knox Co, May 8, 1933, D M Johnson, *Carpinus* Four specimens from Dune Park, Indiana, Sept 12, 1931, are included here

Erythroneura nigroscuta var **rufomaculata** McAtee

Erythroneura comes var *rufomaculata* McAtee, Bul Div Nat Hist Surv Ill 1924 xv, p 48

Differing from the species in that the vittae of the basal part of the elytra are bright red, while those of the posterior part are pale yellow

Twelve specimens, Haunck's Pond, Middle Bass Island, Ohio, July 22, 1933, M. Auten and D. M. Johnson; one South Bass Island, Ohio, Aug. 3, 1920, C. I Bliss; and one Dune Park, Ind., Sept. 12, 1931, E. P. Breakey.

Erythroneura attenuata n. sp.

(Fig. 2)

Ground color opaque white, color markings bright red to orange. Vertex, narrow median inverted orange U with lateral arms connecting with narrow vitta bordering eye; pronotum, median Y with very thin arms, not reaching anterior margin, narrow streak behind either eye; scutellum, basal angles yellow, red-margined outside, and tip red; elytra, anchor-shaped vitta of clavus very thin, a small spot at apex, corium with thin stripe near base, another at base of costal plaque widening at side of plaque with an arm extending forward to meet base of claval anchor, the part of vitta near plaque is pale interiorly, a second arm extends to tip of clavus and thence to base of cell M_4. Black line at apex of plaque very thin, and usual spots of apical cells very small; crossveins red, longitudinal veins of apex pale, cells smoky except for part bordering crossveins, which is pale. Below entirely pale yellowish; ovipositor in female black-tipped, male plates pale and appressed; dorsum of abdomen dark discally.

Inner male genitalia. Style, posterior point as long as base of foot and at less than a right angle to it, anterior point sharp, less than right angle; oedagus bell-shaped, processes thick, rough, parallel and not exceeding the oedagus when viewed ventrally, in lateral view curved dorsally at tip; hook, interior point short, thick, exterior thin, and twice as long, base half as long as outer point and meeting it at about a 45° angle.

Holotype, female, Cantwell Cliffs, Hocking Co., Ohio, Oct. 23, 1932, D. M. Johnson; allotype, male, same data; and paratypes, three Adams Co., Sept. 1, 1931, E. P. Breakey, *Vitis;* one Richland Co , May 8, 1933, M. Auten. Other Ohio specimens are from the above localities and from Athens, Sept. 11, 1920, H. Osborn; Knox Co., May 8, 1933, *Carpinus*, M. Auten and D. M. Johnson; and Williams Co., Sept. 5, 1931, E. P. Breakey.

As the color markings are discontinuous, this species may be considered as rather close to *E. comes*.

Erythroneura vaga n. sp.

(Fig. 3)

Ground color of vertex, pronotum and scutellum white, of elytra semihyaline; markings vague, orange. Traces of vittae of vertex and pronotum present in usual *comes* pattern; scutellum, angles yellow, median vitta white, elytral vittae narrow, continuous from above

middle of humeri with projection to commissure at middle of clavus, diagonally back to middle of costal plaque, thence to base of cell M_4, a spot at apex of clavus, corium, an oblique streak at base, another bordering the plaque narrowly and joining continuous vitta, crossveins red, apical cells dusky, usual black spots small and streak at apex of plaque very narrow

Inner male genitalia Style, heel large, anterior point a right angle, posterior point equal in length to base of foot, narrow, curved to base at less than right angle, oedagus a narrow shaft with two short prongs at slightly enlarged apex, no processes, in lateral view, prongs turned up pygofer hook with points about equal and tips approaching one another

Two specimens, male (holotype) and paratype (abdomen missing), Mineral Springs, Ohio August 31, 1931, H Osborn

Erythroneura tricincta var **noncincta** n var

There are no true crossbands in this variety which is closely related to *Erythroneura tricincta* var *calvcula*, as the basal angles of the scutellum and sides of pronotum behind the black eyes are dark There are dark reddish triangular spots, bordering side of costal plaques, and not attaining clavi which are immaculate The background is creamy white and faint yellow color streaks follow the longitudinal veins of the elytra The crossveins are narrowly black, heavily margined anteriorly, except the fourth, with bright red, apical cells dusky

Described from one female (holotype) Adams Co, Ohio Sept 1, 1931, E P Breakey *Vitis*, and one female (paratype) Rotten Wood Creek, Georgia, Oct 1, 1933, M Auten

Erythroneura breakeyi n sp

Ground color creamy white Vertex, basal half except for narrow streak next each eye black, and median extension almost to border, about half of width at base, slightly divided apically, pronotum, median Y shaped vitta thick, with arms and base of about equal length and thickness, pellucid orange, an orange mark behind each eye in anterior half, scutellum, basal angles large, orange, tip orange, median vitta creamy white, slightly wider at apex, forming inverted T, elytra, a broad reddish brown red bordered vitta continuous from mid-humerus, bordering costal plaque and extending to base of cell M_4 In clavus the first fourth occupied by vitta half its width, in second fourth widened to tegminal suture Apex of clavus colored, forming a triangle when elytra are closed with a subcircular pale spot anteriorly and on either side and posteriorly a pale longitudinal area In the corium there is a small oblique dash at base and one bordering costal plaque anteriorly, which joins main vitta The anterior half of plaque chalky white and posterior dusty black, crossveins except the fourth, which is pale, and adjacent longitudinal veins, are bright red, apical cells smoky except near crossveins, a very small black spot in apex of R_3 and rather

indefinite dark blotch in base of cell M_4. Below yellowish white, a faint red streak above each antenna; ovipositor dark-tipped and sides of pygofer dark, except pale stripes bordering ovipositor, which are set sparsely with pale hairs.

Described from one female (holotype), Adams Co., Ohio, Sept. 1, 1931, E. P. Breakey, Vitis, and a female (paratype), "Mtn. Grove, Mo., 7-7-15, Horsfall," In the latter, the pronotum is immaculate, tip of scutellum pale, and elytral vittae pale orange basally and bright red discally; below entirely pale.

Erythroneura bistrata McAtee

(Fig. 4)

Erythroneura vitis var *bistrata* McAtee, Trans. Am. Ent. Soc, xlvi, p. 305, 1920.

The difference in the inner male genitalia as well as in the color pattern separate this form from *vitis* and make it of specific rank.

Vertex pale yellow anteriorly with a median red area almost attaining margin and laterally widened at about half its length to eyes which are narrowly yellow-margined. Pronotum entirely reddish brown but for small yellow spot at middle of anterior margin. Scutellum, base brownish red, with narrow pale median vitta; apex yellow. Elytra red but for costal plaque, an area at inner base of clavus extending on to corium, spot involving apex of clavus and adjoining corium, and very small dots anterior to two center crossveins; apex smoky. Below pale yellow, the metathorax dark and abdomen dirty yellow; ovipositor black-tipped; first three abdominal segments dark dorsally, also pygofer, ovipositor and last ventral segment suffused with red in some cases, otherwise pellucid yellow. In male the tips of the plates are dark.

Inner male genitalia: Style, heel small, base straight half way then curved to posterior point, joining it at a little less than a right angle; posterior point not quite as long as base of foot, blunt; anterior point half as long as posterior, sharp. Oedagus triangular apically, with rounded angles and produced medianly; processes thick and parallel for basal half, then narrower and diverging gradually, extending beyond apex of oedagus; pygofer hook large, outer point about a third longer than inner, and narrow.

Specimens from Columbus, Ohio include the following data: July 22, 1921 and July 28, 1928, H. O.; April 29, 1933, M. Auten and D. M. Johnson, on *Aesculus;* May 11, 1933, M. Auten, *Aesculus;* O. S. U. Campus, July 28, 1933, D. M. Johnson, on *Cercis;* and a specimen from Williams Co., Ohio, Sept. 5, 1931, E. P. Breakey.

Erythroneura bistrata var. stricta McAtee

Erythroneura vitis var. *stricta* McAtee, Trans. Am. Ent. Soc. xlvi, p. 305, 1920.

The inner male genitalia are identical with those of *E. bistrata* and the color markings less extensive.

Ground color creamy white; vertex chiefly yellow with touches of red near posterior margin; pronotum reddish brown but for one or more pale spots at anterior margin; scutellum reddish brown basally with paler narrow median vitta, and pale tip; tegmen with three cross-bands, anterior red, margin not exceeding scutellum, middle red, occupying central third of clavus and extending transversely to costal plaque which is black for more than half its length; apex dusky; cross-veins red, the areas between them anterior to central cells washed with red. Below same as in *bistrata*.

Collected in Columbus, Ohio, July 28, 1933, *Cercis*, D. M. Johnson; July 28, 1928, H. Osborn; July 27, 1921, H. Osborn; May 11, 1933, *Aesculus*, M. Auten; and Williams Co., Ohio, Sept. 5, 1931, E. P. Breakey.

BOOK NOTICES

Endocrine Chemistry.

This very practical volume deals with the preparation and chemical composition of the hormones. No more promising branch of biology exists than endocrinology, and no more fundamental portion of endocrinology can be concieved of than the isolation, analysis, and synthesis of the internal secretions The physiological and clinical properties of these substances, while not emphasized, are touched on sufficiently to round out the presentation The book appears to be very complete, and the style is straightforward and lucid. To the laboratory worker, the clinician, and the experimental biologist, the book will be invaluable

The Chemistry of the Hormones, by Benjamin Harrow and Carl P Sherwin. vii + 227 pp Baltimore, the Williams and Wilkins Co , 1934. $2.50

The Biology of Bacteria.

This new text is a complete introduction to the study of bacteriology The subject is presented as a biological science, with emphasis upon the fundamental problems of morphology, taxonomy, physiology, ecology, heredity and evolution. Practical applications are not unduly stressed, but are inserted where they seem desirable. The relation of the protozoa, fungi, and other forms of microbic life to bacteriology are developed. Numerous illustrations add to the value of the text material.

The Biology of Bacteria, by A. T Henrici. x+472 pp. Boston, D. C. Heath and Co., 1934. $3 60.

The Biology of Cells

The third edition of this well-known text presents an up-to-the-minute discussion of the modern cytological viewpoint It is an excellent presentation, and covers particularly well the recent advances in cyto-genetics. Fragmentation, translocation, segmental interchange, heteroploidy, chiasma formation and other chromosomal phenomena are clearly and adequately discussed One finds it easier, for example, to digest Darlington's recent interpretations from this presentation than from Darlington's own writings. The volume is profusely illustrated, both with photomicrographs and diagrams. Excellent discussions of the relation of genes and chromosomes to embryology, to sex-determination, and to evolution, round out the book. An exceptionally complete bibliography of nearly one hundred pages is appended.—L. H. S.

Introduction to Cytology, by Lester W. Sharp. (Third edition, revised). xiv+567 pp. New York, the McGraw-Hill Book Co., 1934.

Laboratory Geology.

This is a Manual, not a text, of Historical Geology and as such is adapted for Laboratory use. There are five exercises in Paleontology, six on Structural Geology, and five on Regional Geology. It is so arranged that there are places for notes and the exercises can be torn out for handing in to the instructors. Although primarily fitted for Field's "Historical Geology," it is easily used with other "Texts."—WILLARD BERRY

Geological Manual, Part II, Historical Geology, by Richard M. Field xii+200 pages, paper bound Princeton, the University Press, 1934.

The Physiology of Domestic Animals.

The past decade has witnessed a growing need for an authoritative English textbook devoted to the physiology of domestic animals. For some time instructors and students of Veterinary Medicine and Animal Husbandry have been forced to utilize the various textbooks of human physiology in order to keep pace with newer developments in the field.

Professor Dukes has succeeded admirably in his attempt to present a suitable textbook for students in Veterinary Medicine and Animal Husbandry This book will also serve as a welcome reference for the veterinary practitioner

The subject matter is divided into eleven parts each of which is complete in itself. These eleven parts are further subdivided into thirty-nine chapters. This arrangement permits teachers to treat the various subjects in the order which best suits their particular courses At the end of each part is included a comprehensive bibliography which adds materially to the value of the book for use either as a text or reference

The effectiveness of the book is insured by the concise and direct nature of the author's discussion and by his free use of illustrations, graphs and tables.

This book is a valuable addition to the literature pertaining to the physiology of domestic animals and it should find ready acceptance by instructors, students and practitioners —E. E HEIZER.

The Physiology of Domestic Animals, by H. H Dukes. xix + 391 pp , 218 Fig. Edwards Brothers, Ann Arbor, Michigan, 1933 $5 00

More about the Universe.

Galaxies and nebulae, space and time, molecules and atoms, positrons and electrons, quanta, relativity, the fate of the universe—these are words to conjure with in this age, when the general public is making best sellers of books like this one Joining the parade so ably led by Jeans, Eddington and Bragg, this volume will make fascinating reading, albeit difficult at times, for a science-conscious world The author writes in an easy conversational style, forseeing all objections and difficulties on the part of the reader, and making abstruse ideas as clear as they can probably be made to the non-physicist. For those who like their science spiced with ready wit and happy illustration, this book is recommended.—L H S

The Architecture of the Universe, by W. F. G. Swann. ix + 428 pp New York, the Macmillan Co , 1934 $3 75

Termites or "White Ants"

This is the most complete and comprehensive treatment ever published upon this important subject. Their biology and habits are thoroughly discussed by authoritative workers as well as their reactions and relationships to plants and plant products. Part II discusses the toxic qualities of chemicals to termites. Part III deals with the problems of resistance of certain types of wood to their attacks and the remainder of the book deals with various control and prevention measures. Since the termite has assumed such an important role in the economic field and annually causes such enormous losses, this book is invaluable for the economic entomologist and is an excellent volume for all who are interested in the biologic field. Such men as S F. Light, A C. Horner, Merle Randall, W. B. Herms, and Earl E. Bowe have all been major authors in this work.

—D M. DELONG

Termites and Termite Control, by Charles A. Kafoid. xxv+734 pp. Berkeley, University of California Press, 1934.

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THE PROPERTIES OF THE VISUAL EXCITATION-CURVES

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A graph which is built upon the explicit assumption that a certain quantity is to be held constant can convey no information about any changes which presuppose that this quantity is also variable Many studies which have been made of vision often seek to extract information from a graph respecting some property which had already been definitely assumed to be constant. A function such as

$$V = 32t$$

describes how a body falls This function is linear and one can see readily that the area under this curve, between given limits, embodies or represents the total distance traveled by the falling body. The ordinate of this curve represents the instantaneous velocity of the object, while the slope of the curve embodies the acceleration of the object.

In the study of the phenomena of vision the fundamentally illuminating experiments are those of intensity discrimination and of acuity. In many of the early attempts to measure the ability of the eye to detect intensity changes and acuity changes one finds the effort made to extract information about intensity discrimination from graphs which were derived through keeping intensity constant The converse is also often made, when persons seek information regarding frequency discrimination from experimental data gathered when frequency was held constant.

The excitation and the Elementarempfindungen curves are graphs which were worked out by taking certain arbitrarily chosen primaries. The ordinates represent the amounts or the numbers of the units of the chosen primaries; the area under the excitation curve will (and does) represent luminosity or,

if one prefers, the number of functioning rods and cones while the slope of the curve depicts hue discrimination or the magnitude of the change in hue that a given eye can detect. In the case of the excitation curve we can readily interpret both the instantaneous value of the function, and the area underneath the curve and also the slope of the curve in terms of visual discriminations, just as readily as the physicist can assign physical meanings to the corresponding properties of the curve depicting the behavior of a falling body.

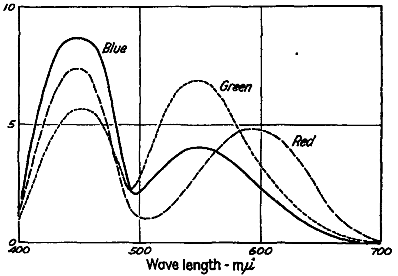

Fig 1. Helmholtz's three fundamental primaries.

In the study of vision the following facts are explainable if the axis of abscissae be variable wave length: (1) color-blindness; (2) luminosity or brightness; (3) color-mixture phenomena; (4) hue-sensitivity; (5) hue-discrimination; (6) white complementary color pairs; (8) saturation; and (9) minimal hue detection. The facts are explainable without bringing in anything regarding a variation of intensity as will be seen later and much more fully in subsequent studies. The visual psychological properties that are interpretable in terms of varying intensity of the light stimulus constitute another distinct group. In explaining the above group we keep the intensity constant and vary only the wave length.

As the excitation curves are given us by Helmholtz (1) (see Fig. 1) and many others, it is impossible to read off from them the nine psychological characteristics mentioned above. Hecht (2) recognizes that it is possible to apply a simple homogeneous linear transformation to these historic excitation curves and so transform them that they will give the above-mentioned items of information regarding the nature of the visual process. Since these excitation curves are not the direct product of experimental data, a certain non-uniqueness belongs to them as the result of a mathematical operation upon other functions which *were experimentally determined*. Those who set up the excitation curve for us were not restricted in their

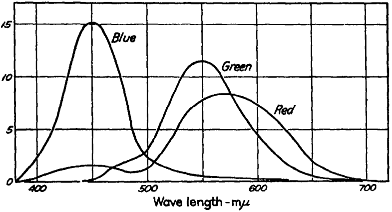

Fig. 2. The curves as determined from the data of Wright.

choice to any particular set of three primaries If, for example, one takes the curves of Wright (3) (see Fig. 2), he can apply his mathematical technique of transformation to an infinite number of, sets of three, assumed or pseudo-primaries. There is only one restriction which operates to prevent the absolute freedom of choice of the three new pseudo-primaries. This can be illustrated thus: Suppose that *Wright* took B, G, and R to be his primaries and that the *reader* chose to take colors x, y, and z to be his primaries where x, y, and z are thus defined:

$$x = a_1 B + a_2 G + a_3 R$$
$$y = b_1 B + b_2 G + b_3 R$$
$$z = c_1 B + c_2 G + c_3 R$$

In this transformation the new primaries are *functions*, (not arithmetical numbers), of the red, green and blue that

were primaries, for example, as postulated by Wright. One can again state the new or pseudo-primaries as connected up with still other primaries as:

$$u = l_1 x + l_2 y + l_3 z$$
$$v = m_1 x + m_2 y + m_3 z$$
$$w = n_1 x + n_2 y + n_3 z$$

Such transformations show that any set of three colors can be taken as primary provided that in making the transformation the determinant in the denominator does not vanish.

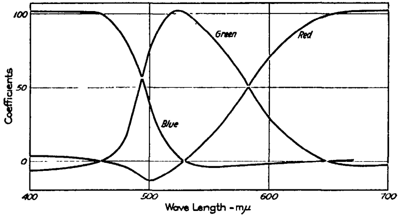

Fig 3. The curves of Koenig and Dieterici.

Suppose that we solve for B in the set of equations just given,

$$B = \frac{\begin{vmatrix} x & a_2 & a_3 \\ y & b_2 & b_3 \\ z & c_2 & c_3 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}}$$

If the determinant in the denominator vanishes, then we find that we selected as a primary, a color which cannot serve as such in this set of equations got from the original experimental curves. In the function, which defines x, y, and z the symbol

B = a certain unit amount of blue,
G = a certain unit amount of green,
R = a certain unit amount of red.

The primary x, where, to be specific, x is say $\lambda = 500$ m μ of the given spectrum, might be thus represented,

$$x_{500} = 50R + 250G + 75B,$$

that is, it takes 50 units of R plus 250 units of G and 75 units of blue to match the color of $\lambda = 500$ of the spectrum which is being matched. Similar equations would tell how to duplicate the remaining two primaries, namely, y and z.

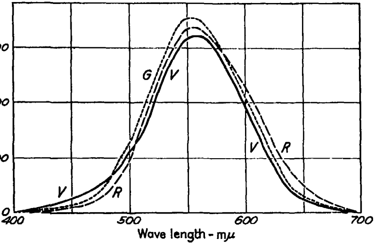

Fig. 4. Hecht's transformed excitation curve.

Again suppose that one knew both that 450 m μ = 102B + 2G + 4R, and that

$$B = [(a_1)x + (a_2)y + (a_3)z]$$
$$G = [(b_1)x + (b_2)y + (b_3)z]$$
$$R = [(c_1)x + (c_2)y + (c_3)z]$$

it then follows that

$$450 \text{ m } \mu = 102\ [(a_1 + b_1 + c_1)x] + 2\ [(a_2 + b_2 + c_2)y] - 4\ [(a_3 + b_3 + c_3)z]$$

Thus one demonstrates that it is possible to get an infinite number of sets of equations of x, y, and z. The student must, therefore, be alert to note whether or not the equation describes the primary of the experimental curves or of the transformed curves. By making such a linear homogeneous transformation the student of vision can move backwards or forwards from any set of three (primaries) to any other

EXCITATION CURVES

These excitation or sensation curves were first obtained experimentally through mixing colors. Some spectrum was taken as standard and then through a process of matching, using only three different colors, this entire spectrum was duplicated. This process can readily be sensed by the reader from Fig. 5. Here is a three-fold source of light and it is easy to project, upon a screen, such amounts of the three colors as will duplicate any desired part of the spectrum assumed as standard.

Since these curves are the graphs of data embodying color mixtures which occur when the spectrum which we used was

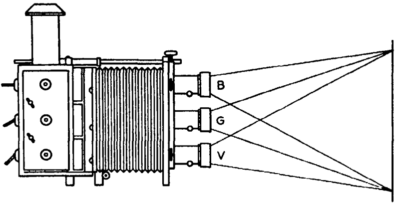

Fig. 5. A method of mixing colors so as to duplicate a standard spectrum.

a constant energy spectrum or the equivalent, it follows that these three sensation curves do not include variations of intensity. In a preceding section we showed that intensity cannot be represented (save as it is a constant) by means of these curves. Attempts have been made, by some who had not reasoned out very thoroughly the facts in the case, to introduce brightness into these curves. Hecht points out two such attempts (2).

One of these attempts rested upon the assumption that there are three groups of receptors in the retina, but there are not the same number of receptors in each group. Experiments by Judd (4), and others (5) pointed out the fact that some colors are very much more effective in aiding in producing white than others. For example, it takes a great deal more

yellow to cancel violet than it does of wave length 576 m μ to cancel 475 m μ and again the relative amounts here are very different from what they are for 609 m μ and 494 m μ. The result of these experiments was taken to mean that the population of the cones is as 1 : 75 : 100. There are said to be 75 green-producing cones and 100 red-producing cones to every one of blue. The other attempt to incorporate brightness into these sensation curves made the assumption that the number of cones of each family is the same as the number of the other two families and that at any particular threshold of stimulation the functioning receptors are distributed among the three families and that in each case where the psychological experience is an experience of white that the cones are functioning in the ratio of 1 blue to 75 green, and to 100 red Both these attempts to read luminosity or brightness into the excitation curves involves a serious weakness. Let us consider the latter expedient first. This says that there are the same number of cones of each family, but that one sees white when they are excited in the ratio of 1 : 75 : 100 Let us take a few examples here to show how the flaw in this assumption can be made manifest.

Blue	*Green*	*Red*	*Experience of the Individual*
1	75	100	Sees white
10	750	1000	Sees white
14	1000	1000	Does not see white
600	1000	1000	Sees blue

This table can be extended indefinitely. If the individual sees only white when the stimulated cones are in the ratio of 1 : 75 : 100, and if there are equal numbers of cones of each family, it follows, since the red cones are brought into play a hundred times as fast as the blue, that the former will all be called upon to function long before all the blue and green cones are From that point on until the last cone threshold of the blue shall have been reached, no more red cones can be set into action and as the result of this, from here on there must be a color which is the result of the interaction of the green and the blue. Again, as there are 75 green cones called into action for every one blue cone, it follows again that, as we increase the intensity of the light, all the green cones will have been set into action long before all the blue cones are functioning. When such intensity of light has been reached

which has set not only all the green cones but also all the red cones into action, then with all additional augmentations of the intensity of the light there must be experienced a blue color. This is inevitable because of the predominance of the blue cones activated as over against what is called for by the proportion 1 : 75 : 100.

In this way it is clear that if one would take white light and stimulate the retina, the subject would, at first, see white; then as the light is further increased there will be experienced a hue which is the resultant of the operation of the green and blue cones, as soon as all the red cones will have been set into action. Further increasing of the intensity of the stimulus will be accompanied by an experience of the colors of the violet end of the spectrum as soon as the green cones have been set into action.

This attempt to have the excitation curves incorporate the data of brightness very evidently involves the presence of a fallacy, for the simple reason that as we take white light and stimulate the retina with it we experience white or gray all the way up from light of lowest intensity to light of maximum intensity. Thus this theory that there are equal numbers of cones of each family and that the experience of white is the correlate of the action of these in the ratio 1 : 75 : 100 breaks down If an individual experiences white all the way up from light of minimal intensity to light of maximal intensity it cannot follow that the population of the cones and their action are as this assumption postulates.

The second assumption still rests on the fact revealed by experiment to the effect that the relative efficacy of the colors in producing white is as 1 : 75 : 100. But how incorporate this property of brilliance into our curves which have been made only to express color-mixture data?

The situation so far is that those who gave us our excitation curves had a multiplicity of units (three). They had a unit of V, another unit of G and still another unit of R. What they then wished to do was to replace these three sets of units by a single unit. The lay of the land at the time can be shown thus. Three possibilities are open to the student of vision. They are: (a) one unit of V, one unit of G, one unit of R; or (b) a common unit of energy; or (c) a unit of brightness. Some writers continued to stumble along seeking to clear up the problems of vision by utilizing the threefold set of units. While

they continued to do this they were unable to introduce into the curves anything more than what they had put into them; namely, color mixture data. Soon numerous attempts were made to introduce or to incorporate other facts into them. Brightness was chosen as one to be incorporated into the curves. The fact that brightness is a property of both "hue vision" and "white light vision" constituted it an outstanding trait of all visual experiences In the dimmest light and throughout the entire range of moderate intensities as well as at maximal intensities, brightness is an ubiquitous trait. Perhaps it was for some such reason that students early attempted to incorporate this property into their curves We have already seen that one attempt was made which proved premature. The second attempt made seems to be much more hopeful of meeting with success

This attempt was made by those who were aware of the experimental findings which showed that violet was much more effective in producing white, when in combination with the other colors, than was either green or red. Carefully made experiments showed that this effectivity for producing whiteness of the various cone groups was as 1 . 75 : 100. One violet cone is as effective in giving white (or gray) as are 75 green cones, or as effective as 100 white cones

Suppose then that these men assume that the population of the cone groups in the retina is *not* equal in number. This was taken for granted by those who made the preceding assumption. Let us, therefore, accept the ratio 1 : 75 : 100. This seems to be a very reasonable hypothesis. Since one blue or violet cone is as effective as 75 green cones in production of white, then, what is more natural than that there should be 75 times as many green cones as there are violet cones? Likewise, since a violet cone is as effective, in the production of white, as 100 cones of the red producing group, what could be more plausible than to say that in the retina there are one hundred times as many red producing cones as violet producing. On this assumption hue would result from a stimulation of such a magnitude and of such a character as not to stimulate the cones in the proportion of 1V · 75G : 100R. Any stimulation which sets up an imbalance, from the standpoint of this ratio, would produce an experience of hue, and similarly any stimulation, no matter what its intensity (within the limits of the eye's sensitivity), which stimulated the cones in this

ration of 1 : 75 : 100, would give rise to the experience of gray or white. Surely here is an assumption that one is prone to say must be adequate.

Now what about the hypothesis that the total population of the cones of the three groups or families is in the proportion indicated by the experiments on the relative efficacy of the different cones in producing the experience of white? Viewing the matter in an *a priori* deductive fashion one feels confident that the assumption is adequate.

Suppose now we get a red as saturated as we can and then increase its intensity. We can make an intensity discrimination experiment on this red and keep a record of the data. Finally we reach the maximum intensity. No brighter red can be discriminated by the eye than that which results when the light is of such intensity as to set all available cones, of the red family, into action. The brightest red we can discriminate is one which is brought about through the activation of all the cones of this particular family. Another experiment of the same kind can be made with green light and with a similar result and implying the same sort of interpretation. Let us now take a violet or blue and run this through the same type of experiment. If our assumption as to the relative distribution of cones were true, we would be unable to get anything like so many intensity discrimination steps when working with the violet as we do with the other two primaries If we have only one violet cone to each 100 of the red family cones we could never get so bright a blue as we can a red or green Likewise in the case of the green. Since brightness is shown to be proportional to the number of functioning retinal elements we could never have a green so bright as the maximum red and by far more would our maximum brightness of the blue fall short.

Experiment contradicts this We can have a blue as bright as our brightest green or even our brightest red So falls by the wayside this second attempt at incorporating brightness into the excitation curves. A new attempt remains to be made. It is a very simple matter to contrive a theory of vision that will explain a few detached facts, but what the scientist seeks is a theory that will simply embody or display all that is experimentally gleaned in the laboratory.

Hecht has developed for us a transformed set of excitation curves (2) (see Fig. 4). These were derived originally from color-mixture experiments and the data so gathered were

subjected to a linear homogeneous transformation. This was, of course, the way that both the elementary and the fundamental excitation curves were obtained. The transformation that gave the above figure was the one from which Hecht proposes to deduce the properties of vision that are correlated with a change in wave length and with intensity kept constant.

THE NORMAL EYE

If these excitation-curves are to explain all the parts of vision under the restriction that the intensity of the stimulus is held constant, certain requirements with reference to the curves are immediately apparent.

(1) They are to represent three equi-numbered groups or families of receptors. To do this the functions are so transformed that the area under any curve is equal to the area of each of the other two

(2) The demand is also made by the one setting up these transformed functions that the summed area under all three of these curves taken separately shall add up to give the observed visibility curve of the spectrum. Stated otherwise, this is the same as saying that the *sum* of the area under each of these three curves shall give the observed or experimentally checked visibility curve. It follows, also, incidentally that the total area under the curve which is the sum of the three separate excitation curves will represent the total number of functioning receptors when the *entire* spectrum is applied, and not some monochromatic light.

This second requisite will immediately cast out the experimental curves of Wright (see Fig 2) as well as the excitation curves of Helmholtz (see Fig 1) and other transformed functions such as those of Koenig. The visibility curve is a smooth continuous function having but one maximal value Such a curve can not be got from the excitation curves of either Wright or Helmholtz. If one adds the ordinates of the Helmholtz excitation curves he will find that the resultant curve will have two maximal values and not one as is the case with the visibility curve. Since this is the state of affairs it follows that the elementary and the fundamental curves will not prove adequate to the task of explaining the visual process as a whole.

(3) These curves that we accept must be consistent with the observed hue experience. That is, these curves must tell something about the experience of different colors and also

about the *how much* of the experience. Later on it will be shown that this information will be imparted by adjusting the relative ordinates or heights of the excitation curves.

(4) These curves must also be consistent with hue discrimination. This item of the visual process will be inserted in the *slopes* of the curves. The reader will remember that in the case of the falling body the slope was constant and he will also persistently bear in mind that in this case he has three curves to grapple with, and not just one simple linear function, as in the case of the law of the falling body. *Hue* discrimination is, therefore, to be determined from the slopes of our three excitation curves, whereas observed hue is to be interpreted by the *relative* heights of the curves at any given wave lenght.

(5) These curves are constructed to describe the normal eye, and they must therefore not be expected to tell all about the vision of the abnormal eye, but there are several things that have been observed about the color blind which suggest the possibility of making significant minor adjustments in the excitation curves describing the normal eye.

(6) Our curves must also embody information regarding white complementary colors This matter of color complementariness gives another "look in" at color mixture with the result that we find embodied in this phase of the problem of vision that several of the laws of algebra hold and that the numbers involved are of the character of complex numbers involving a real and an imaginary component.

(7) Once one has detected the real nature of what is at work in the experience of white complementariness he is literally forced into the making of a quantitative study of the phenomenon of saturation. Again if the three excitation curves we have settled upon are to be suitable for an adequate theory of vision we must be able to read the facts regarding saturation directly from our curves.

The above seven requirements are made of any set of curves which is to describe our visual experience. Will the three curves of Hecht meet these demands? Evidence of their adequacy is here given in the form of a quantitative analysis of hue discrimination.

AN APPLICATION OF THE VISUAL EXCITATION CURVES

The function V = (32)t which describes the behavior of a falling body, displays three distinct bits of information: the instantaneous value of the velocity; the total distance traveled, and the acceleration. In this case the acceleration is zero.

In the problem we are concerned with, we have not one but three curves with which to deal, and it is evident that we have a right to expect them to impart much more detailed information than could possibly be given by a single function In the case of the function

$$V = 32t$$

we have a constant slope, whereas the excitation functions have varying slopes throughout and further significant properties emerge as a consequence of the fact that they intersect at different points (5) The relative differences of the ordinates of these functions, corresponding to a given wave-length, are quantities which describe the most variable and individual property of vision.

The total area under the three curves (see Fig 4) is a measure of the total number of functioning retinal elements (2). The area enclosed under the "visibility" curve expresses this number under the condition that prevails when the eye is stimulated by the entire spectrum, while the ordinate is a measure of color mixture, luminosity or of the number of receptors functioning in response to monochromatic light. The *relative* differences between the ordinates corresponding to a particular wave length is found, both through experiments and mathematical description, to be an extremely accurate measure of the experience of hue The slopes of the curves in turn give us an excellent measure of hue discrimination. These properties are compactly given thus: A = area = number of activated receptors; $\frac{dA}{d\lambda}$ = O = ordinate = luminosity, etc ; D = relative difference of ordinates for a corresponding wave length; = hue sensitivity; and $\frac{d^2A}{d\lambda^2}$ = slope = hue discrimination.

Perhaps one of the most telling arguments in support of the three-receptor theory of color vision is brought out clearly by means of these excitation curves On an average there is a decided constancy of both "A" and $\frac{dA}{d\lambda}$ as shown by experi-

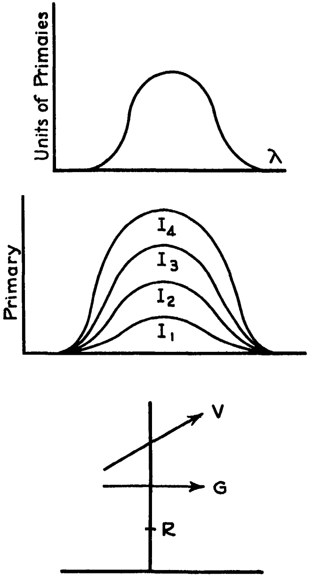

Fig. 6. (Upper). Fig. 7. (Center). Fig. 8. (Lower).

ments on different individuals. Taken in the large the element of individuality of the eye is shown progressively as one passes from the study of A, to the study of $\frac{dA}{d\lambda}$, and then to the study of $\frac{d^2A}{d\lambda^2}$. In life we recognize each other as individuals and accord to each person a uniqueness which makes him an unsubstitutable object. Science washes its hands of the attempt to get the unique, so say many scientists. Yet all know that as the order of the differential equation advances it calls for the positing of more and more initial or boundary conditions. Along just this way lies individuality. The more individual any affair is, the higher is the order of the differential equation. In our present problem we find that the only aspect or property of our curves which can be very greatly changed, relatively, and still leave the areas under the curve virtually unchanged is the slope of each of these curves. We can make a large change in the relative slopes of these curves at almost any point and yet keep our enclosed area a constant. In this respect we have a new light as to how these excitation curves may serve as a realistic account of the retinal physiological processes. The most variable feature about vision is the ability of the eye to make hue discriminations.

Since one of the most variable properties of the eye is its functioning in making hue discriminations it is certainly significant—and a telling blow for the three-element theory—that there is an aspect of the curves that lends itself to great modifications and yet, at the same time, leaves unaltered the total area under the curves. If we had but one curve it would be utterly impossible to do this However, since we have three curves, each enclosing equal areas, and since these are placed as they are it is perfectly simple to change their relative slopes greatly without affecting the total area enclosed. This variability of the slopes of the three curves then is a trait that can be easily varied, its psychological correlate is given us by the fact that hue discrimination is equally variable from eye to eye. To fit our excitation curves for one eye and then for another, we are called upon only to vary the relative slopes of these curves. We can easily strike a general average that holds for many eyes in terms of A and $\frac{dA}{d\lambda}$. This is but a

way of saying that these two quantities are fairly impersonal. It is not so easy to do this with the quantity $\frac{d^2A}{d\lambda^2}$. This quantity tells us something that is quite personal about the eye. It is not evident how we could get this high individual variability characteristic of hue discrimination if we did not have a multiplicity of excitation curves. Again, we say that this is one of the most significant arguments for the adequacy of the Young-Helmholtz theory.

The problem now before us is to check hue discrimination and to say just how it shall be given to us by the curves. (See Fig. 6.) At the two extreme ends the slope of the curve shown in Fig 6 changes very slowly—hue discrimination is very poor at those places. At the top the slope is quite flat, almost horizontal for some distance; here also the discrimination of hues is very poor. If we were to vary the intensity I of the stimulus we would find that the curves would be of this general character (See Fig. 7.) The greater the intensity the flatter the curve would be at the top

Experimentally what must be done in carrying on a measurement of hue discrimination is to keep the hue intensity, $L_H(\lambda)$ = constant and make the change in the hue. If we could not do this our measurements would be meaningless. A table may be helpful, at this point.

λ_1	V	G	R	L_H	L_W	L_t
500	40	30	25	20	75	95
550	45	30	20	35	60	95
330	43	27	25	20	75	95
	48	27	20	35	60	95

In making readings the student must exercise caution in noting which curve is the lowest in the region where he is taking the measurements. The balanced part of the visual effect is always three times the value of the least ordinate at the wave-length considered Let us take the cases where

$$\left\{\begin{matrix} V_1 = 48 \\ G_1 = 27 \\ R_1 = 20 \end{matrix}\right\} \text{ and } \left\{\begin{matrix} V_2 = 45 \\ G_2 = 30 \\ R_2 = 20 \end{matrix}\right\}$$

$$\Delta H = (V_1 - V_2) + (G_1 + G_2) = (48\text{–}45) + (27 + 30)$$

This expression gives us the rates of change of the ordinates for V and for G. The reason that the ordinate of the red curve does not appear is that care was taken to keep the luminosity constant. To be more accurate what is kept constant is the white luminosity. Having found the relative differences of the two biggest components for any given lambda and having equated this to H, we may now get the rate of change of hue with respect to wave length by dividing the above equation by $\Delta\lambda$.

There results:

$$\frac{\Delta H}{\Delta\lambda} = \frac{V_1 - V_2}{\Delta\lambda} - \frac{G_1 - G_2}{\Delta\lambda}$$

$$\therefore \frac{dH}{d\lambda} = \frac{V_1 - V_2}{(d\lambda)} - \left(\frac{G_1 - G_2}{d\lambda}\right)$$

to the right of the point where we have the first intersection of the lowest curve the variable which will disappear from the equation is V Thus the measure of hue discrimination for all wave-lengths to the *right* of the point where the Red and Violet intersect will not involve V The expression for hue discrimination throughout this interval is given by

$$\frac{\Delta H}{\Delta\lambda} = \frac{R_1 - R_2}{\Delta\lambda} - \left(\frac{G_1 - G_2}{\Delta\lambda}\right)$$

$$\frac{dH}{\Delta\lambda} = \frac{dR}{d\lambda} - \frac{dG}{d\lambda}$$

This information can be shown graphically in a way that may help the reader to a better appreciation of how hue discrimination is measured. Let us take a particular ordinate and let points on it indicate the points where it cuts the excitation curves. (See Fig. 8.) At the points V and G are indicated the slopes of the V and G. curves If these indicating lines are diverging, converging or parallel the hue discrimination will be an increasing, decreasing or a constant function.

From the curves that have been finally accepted as giving a description of the facts of vision it is easy to show from the equations below,

$$\frac{dH_1}{d\lambda} = \frac{d}{d\lambda}(V_\lambda - G_\lambda)$$

$$\frac{dH_2}{d(\lambda)} = \frac{d}{d\lambda}(R_\lambda - G_\lambda)$$

the right hand side of each equation to be a function of lambda. From this we have that

$$\frac{dH_{(\lambda)}}{d_{(\lambda)}} = f\,(\lambda)$$

On this assumption we may say that

$$\frac{\Delta H_{(\lambda)}}{\Delta_{(\lambda)}} \approx f\,(\lambda)$$

Here we take a certain finite increment of $H_{(\lambda)}$ and assume it to be constant and at the same time ***equal to the least perceptible change*** in hue. Since $\Delta H_{(\lambda)}$ = constant, it follows that constant $\approx f\,(\lambda).\,\Delta(\lambda)$.

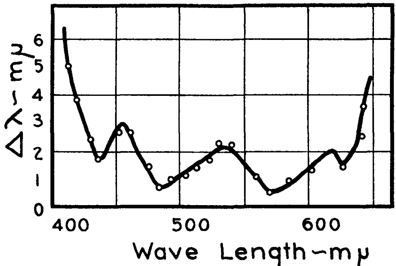

Fig. 9 The data of hue discrimination of Lauren's eye taken from Laurens and Hamilton '29. The smooth curve gives the data, whereas the points are computed from the primaries V, G, and R.

It remains, therefore, only to plot the function between $\Delta\lambda$ and λ and then to check this curve with the data from experiments (See Fig 9.)

The curve here shows a remarkable correspondence between the facts revealed by experiments and the calculated curve is sufficient proof that herein is offered a satisfactory method of measuring hue discrimination.

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Petroleum in 1934

This volume contains papers and discussions presented before the Petroleum Division of the American Institute of Mining and Metallurgical Engineers at the Los Angeles (September 29, 1933), the Dallas (October 6 and 7, 1933) and the New York (February 19 to 22, 1934) meetings. For necessary clearness these papers are grouped in five chapters. Chapter I considers "Production Engineering and Engineering Research," with 14 papers (100 pages). To mention four important contributions in this chapter. "Properties of Hydrocarbon Mixtures as Related to Production Problems," by W. K. Lewis, in which he shows that by appropriate technique the volume of both gas and oil in the crude flowing from a well can be calculated as a function of the pressure at the point in the producing sand, provided one knows the sand temperature This being the case it should explain the high gasoline content of high pressure gas caps. A second paper, "A Theoretical Analysis of Water-flooding Networks," by M Muskat and R. D. Wyckoff, in which the theoretical efficiency of staggered line drive, direct line drive, five-spot, and seven-spot methods of flooding with water to force the oil out into predetermined producing wells is considered A third, "Recent Changes in Reservoir Pressure Conditions in the East Texas Field," by G. L Nye and C E Reistle, Jr, who endeavor to show that the reservoir pressure is dependent on the rate of production and that with slow production the total recovery would be greater due probably to the slow vertical flooding by natural waters A fourth, "Basic Data for Oil and Gas Wells," by L. J Pepperberg and E A. Stephenson, with an excellent bibliography of 84 titles. Chapter II is "Petroleum Economics," covering 40 pages with six papers, two of which are (1) "Tanker Rates and Canal Tolls as Factors Determining Markets of Foreign Oils," by V. R Garfias, with comprehensive tables showing costs; and (2) a table, "World Petroleum Consumption," by V. R. Garfias and R V Whetsel, covering from 1931 to 1933 inclusive, showing a grand total of 1,366,291 thousand barrels consumed in 1933. Chapter IV (278 pages) covers world production of Petroleum for 1933 The production is given country by country by various authors. The tables include much more detailed information than before; a procedure which is to be followed in the future. Chapter V contains a paper by W Miller, "Developments in Refinery Engineering during 1933," which is a summary of Refinery development during the year.

This useful volume is a necessary part of all those interested in Petroleum. To those familiar with this series nothing need be said; to those unfamiliar with it, it may be stated that these volumes represent the cream of the Petroleum papers from the Economic and Industrial end —WILLARD BERRY

Petroleum Development and Technology, 1934. Trans. Am. Inst. Min and Metal Engineers, Vol. 107, 466 pages; numerous tables and figures New York, 1934.

NEWER ASPECTS OF NUTRITIONAL ANEMIA

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Nutritional anemia is a deficiency disease belonging to the physiological types of anemia. Abderhalden (1) in 1899 was the first to demonstrate this type of anemia in white rats fed a sole milk diet Bunge (2), a year later, showed that milk was notoriously low in iron content. Nothing of value was developed in this regard until Hart (3) in 1925 reported the remission of the anemia by the feeding of iron and copper. He further stated that inorganic iron alone was ineffective, and that green plant material, an alcoholic extract of this material, or chlorophyll itself was essential for the assimilation of the iron. Hill (4) is also of this opinion

Beard and Myers (5) in 1931 showed that copper was not a necessary adjunct for the assimilation of iron in opposition to Hart's earlier claims. Beard and Myers further stated that other metals (nickel, germanium, arsenic and zinc) would likewise stimulate hemopoiesis. These authors brought forward another point of considerable importance in that they found by doubling the minimum amounts of iron required for the remission of the anemia the time necessary for recovery to occur was reduced from 4 weeks to 1 8 weeks This is in agreement with the results of Leichsenring and Flor (6) in their studies on infants

The problem was further complicated when Osata and Tanaka (7), Furniss (8), and Foster (9), each from separate laboratories, found that ultra-violet light stimulated hemopoiesis.

Scott and Erf (10) in 1930 reported the prevention of nutritional anemia in white rats by a special method of feeding the cattle producing the milk Essentially it was due to the feeding of hay rich in plant pigments and supplemental factors fed to the cows. These same authors (11) later announced that they were able to show a difference in milk obtained from cows which were pasture-fed and those that were fed the ordinary "winter" dairy ration. Hunt and Krauss (12)

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proved that the milk from cows on a green pasture diet had a higher vitamin G content than cows on a dry feed, and that cows on pasture during a vigorous plant growth produced a milk of a higher vitamin G content than those on pasture that was over-mature. Of interest in this connection is the work of Zih (13), who found that rabbits developed an anemia which was not cured by the addition of vitamin B when chlorophyll-free food was used, and the addition of chemically pure chlorophyll, or green food, to the diet caused a rapid return to normal.

Scott and DeLor (14) in 1933 reported rapid hemopoiesis in milk anemic rats by the use of:

1. An iron and copper-free alcoholic extract of alfalfa
2. Haliver oil.
3. Milk obtained from cows on a special feed in which the hay contained large amounts of plant pigment.

DISCUSSION

Early in the experimental work on milk anemia it was demonstrated that factors other than inorganic iron are essential for hemopoiesis It has been demonstrated that chlorophyll is very similar to hemoglobin in chemical composition Pryde (15), in his "Recent Advances in Biochemistry," has pointed out that both hemoglobin and chlorophyll possess a common structural unit known as porphyrin Porphyrin is a complex molecule composed of pyrrol rings Besides pophyrin hemoglobin contains iron and protein which is called globin. Chlorophyll on the other hand possesses magnesium instead of iron and phytol instead of globin. Just what chemical reaction is involved in the relief of hemoglobin deficiency by a supplemental chlorophyll therapy is not known at present. Perhaps it is not the chlorophyll that is concerned; it may be another factor not yet known, or that chlorophyll may be a catalytic agent. In this respect we cannot neglect to mention carotin, which has been shown by Olcott and McCann (16) to be the precursor to vitamin A Our experience with crude carotin has been that it has a primary depressant action on the blood-forming organs in rats on a *normal* diet, followed by a gradual return of the blood picture to normal. It may be that certain impurities present in the crude preparation prevented the carotin from exhibiting its hemopoietic properties.

The action of ultra-violet light in relieving milk anemia is not altogether clear. We know that wave lengths of light in the 300 uu to 680 uu range are capable of doing three things:

1 Sayre (17) has shown that these rays only are capable of producing chlorophyll.

2. In the presence of ergosterol these rays will produce vitamin D.

3. And as shown by Osata and Tanaka (7), Furniss (8), and Foster (9), these same rays will relieve milk anemia.

The action of halibut liver oil can perhaps better be interpreted when we recall that Simmonds, Becker, and McCollum (18) state that liver fats contain vitamin E in considerable amounts and also much iron. These authors claim that vitamin E in some way is hooked up with iron assimilation. They showed that ferrous sulphate alone in amounts as small as .2% in the food was harmful to rats, whereas, ferric citrate or the addition of wheat germ oil to the ferrous sulphate relieved the condition.

CONCLUSION

1. Plant pigments such as the chlorophylls, the carotins, or possibly the xanthophylls apparently are factors necessary for hemopoiesis in rats suffering from milk anemia.

2. Other factors that will relieve milk anemia are:
   a. Milk from cows that are on a specified green pasture diet.
   b. Halibut liver oil.
   c. Ultra-violet light irradiation.

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THE EMBRYOLOGY OF THE WHITEFISH, *COREGONUS CLUPEAFORMIS* (MITCHILL)

PART I

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INTRODUCTION

The importance of the lake whitefish as a food fish has long been recognized, and the recent decline in its population in the Great Lakes is cause for serious concern. Its artificial propagation in state and federal hatcheries has been conducted on a large scale for more than fifty years. Several investigators, Couch ('23), Leach ('23), Van Oosten ('23), Mellen ('23), Koelz ('27, '31), Wickliff ('29), Hart ('30, '31), have made studies on the rate of growth, the age at sexual maturity, breeding and food habits, migrations, and hatchery methods, of this species. However, the literature dealing with the embryology of the Whitefish is confined to two series of microphotographs of the eggs undergoing cleavage, by Leach ('23), and by Wickliff ('28), and to a short description of the unfertilized egg and cleavage stages by Mrs. Fish ('29), whose paper deals primarily with the early life history subsequent to hatching. The present series of papers, of which this is the first number, represents a general survey of the embryology of this species, from fertilization until hatching. This first paper traces the major events of segmentation and germ-layer formation and general development up through the closure of the blastopore. The later embryology and development of each of the organ systems will be treated in subsequent papers. Such a preliminary survey has been made with the hope that it will serve as a basis for further study, and that it will also yield information useful in attacking various hatchery problems relative to whitefish propagation.

MATERIALS

The eggs of *C. clupeaformis* have a prolonged period of incubation, usually extending from the middle of November to the first week in April. Such an extended period permits the

collection of large series of eggs in closely graduated stages. During the winter of 1926–'27, a series of 803 stages was collected at the Ohio State Fish Hatchery at Put-in Bay, under the direction of Mr. E L Wickliff, Assistant Chief of the State of Ohio Division of Conservation The eggs were taken at four hour intervals, day and night from one day after fertilization, November 21, 1926, until hatching time, April 5, 1927, a total of 134 days, 16 hours Temperature readings were made at 8 A M and 4 P. M. daily during this period, using a Fahrenheit thermometer sensitive to fluctuations of one degree. This series is the basis for the present study, and it is now in the possession of the Department of Anatomy of the Ohio State University The author wishes to express his appreciation to the State Department of Conservation and to the Anatomy Department for the use of this material and to Dr. Ralph A. Knouff for his constructive suggestions and criticisms of this study.

For purposes of a preliminary survey, every sixteenth stage of the eight hundred was studied, with additional ones in the early stages, making a series of fifty-five units Those involving early cleavage, germ ring formation, the primitive streak, the formation and closure of the blastopore and the differentiation of the primary germ layers are described from surface views of whole mounts, and from serial sections, in the present paper

Organogenesis from this point to hatching will be discussed in papers II and III of this series This later development is shown by reconstruction drawings, which were built up from serial sections These reconstructions indicate the general development of the brain, sense organs, cranial nerves, notochord, somites, pronephric tubules, the gut, branchial pouches and the heart.

METHODS

All of the eggs were fixed at the time of collection in Bouin's solution. When removed from this, the shell was tough and could easily be removed with needles The yolk was fairly brittle, yet not so hard but that is could be sectioned satisfactorily For most of the series, the sections were stained with iron-alum haemotoxylin, and counter stained with eosin. A few embryos were stained *en toto* in Mayer's acid carmine. Greater differentiation was secured with the former method when the sections were allowed to remain in the mordant, but

not in the oven, overnight and from 24 to 48 hours in the haemotoxylin. The sections were cut ten microns thick and mounted by the water-albumen method.

For the preparation of whole mounts, the embryo was first picked off the yolk with fine needles It was then cleared in cedar-wood oil, stained *en toto* with acid carmine, and mounted in balsam Some of the mounts were simply cleared and not stained. In some respects, these served better for study than the stained embryos

A vertical microprojecting apparatus calibrated to 100 diameters was used in making the reconstruction drawings of the later stages. Since the sections were cut ten microns thick, each section was represented by one millimeter on the drawing. The outline of the entire embryo of the stage to be reconstructed was first made from the whole mount of that stage. After the angle at which the sections had been cut was determined and the base line drawn on graph paper, then the image of a section thrown by the microprojector was transposed to the graph paper by using a pair of dividers to mark out the limits of the part being reconstructed Every fifth section was thus transposed and these sections form the basis for the drawings made at 100 diameters The magnification of the finished drawing is indicated by the size of scale beneath it By this method, the embryo may be reconstructed on any desired plane, parallel to the antero-posterior axis of the body

THE DESIGNATION OF STAGES

All of the eggs in this series were taken from the same incubation jar at the state fish hatchery They had all been fertilized at the same time and subjected to the same temperatures and oxygen content throughout the incubation period. Any wide variation in temperature to which eggs of the same age had been subjected would probably result in marked fluctuations in the relative development of consecutive stages. However, no marked breaks or gaps in the series have been discovered. It is assumed therefore that all normal eggs had developed at approximately the same rate.

With temperatures of the lake in midwinter fluctuating about a mean of 33° F, whitefish in the state fish hatchery at Put-in-Bay have over a period of years had an incubation period of from 120 to 140 days (Leach, '23, Wickliff, '28). However, some embryos in the series described by Mrs. Fish

('29) reached the hatching stage on the 61st day. No temperatures were given for this series. Obviously, different series cannot be compared on the basis of time alone.

There are other bases however that may be used. Wallich ('00) designated the age of fish embryos by thermal units. By a thermal unit (t. u.) is meant a temperature of 1° F. above 32 degrees for a period of 24 hours A mean temperature of 36° F. for one day yields 4 thermal units Thus, when the incubation period for any series or any particular stage in that series is given in days, and the mean daily temperatures are known, the thermal units may be readily calculated by simple addition The thermal unit then expresses the age of an embryo as the sum of both time and temperature. Embryos in different series whose ages in thermal units are the same would be comparable. For example, embryos incubated for 131 days at 34½° F would have been subjected to 325 thermal units and they would be the same age on this basis as other embryos incubated for only 65 days at a mean temperature of 47 degrees. Assuming that this relationship between time and temperature holds within certain limits the thermal unit then may be used as a basis for making comparisons between embryos of different series.

The age in thermal units is given for every stage of whitefish embryos described in this series, together with the age in days. For post-cleavage stages, the length of the embryo and the number of somites are also designated Thus there are four means of denoting the various stages in this series which may serve in making subsequent comparisons.

In the drawings, figure numbers correspond to the serial stage number from which they are taken.

Description of Early Cleavage Stages

The Unfertilized Egg

The unfertilized whitefish egg is approximately 3 mm. in diameter. (See Fig. 1a, Plate I.) It is round, almost transparent when alive, and free to turn in the perivitelline space beneath the shell. The shell is smooth, tough in texture, and is held turgid by the enclosed perivitelline fluid. The perivitelline space is less evident in unfertilized eggs than in eggs subsequent to fertilization. There is a collection of many oil globules at the animal pole of the egg. These are conspicuous

during the early segmentation stages, and underlie the developing germinal disc.

Notwithstanding the fact that a micropyle has been described for the eggs of the salmon (Doyere, '50), for the trout (Henneguy, '88), the carp, the pike, and for various other teleosts, I have failed to discover any indication of such a structure in the whitefish egg.

A thin layer of protoplasm of uniform thickness completely surrounds the yolk

EARLY SEGMENTATION STAGES

Four-celled Stage.—Since the fixation of eggs as originally collected did not begin until twenty-four hours after fertilization, the events concerned with fertilization and the early cleavage cannot be described from this material. Mr. Wicklıff, in the fall of 1927, however, secured eggs from the same source and under similar conditions, taken three hours after fertilization. These eggs were in the four-celled stage. (See Fig. 1b, Pl. I.) Judging from what is known in other species, there must have occurred a "streaming of protoplasm" toward the animal pole, for there is present in these eggs at that pole a rounded disc of protoplasm, lenticular in character. This disc of protoplasm tapers off rapidly at its edge, and continues over the surface of the yolk in an extremely thin layer. The first two cleavage planes are meridional and at right angles to each other. They cut deeply into the blastodisc but do not extend into the yolk.

Eight-celled Stage.—Stage No. 1, O. S. U. series. Incubation period: 1 day; 8 t u. (See Fig. 1c, Pl I.) In the egg that is figured, the blastodisc is somewhat longer than broad, with the eight or more blastomeres arranged roughly as four pairs, one behind the other. In an egg of this pattern, the first cleavage furrow must have been transverse to the long axis of the figure and through its center. The second cleavage furrow would then be at right angles to the first, along the antero-posterior plane. In the rounded blastodisc of the four-celled stage as figured, however, no antero-posterior lengthening can be distinguished. Since the first eggs of the series have already undergone these first two divisions, any attempts to identify the first cleavage planes with the antero-posterior plane of the embryo must be reserved for later study on living material. With regard to the third division, in

Fig. 1c, there must have been two transverse furrows, one through each pair of the first four cells, which by subsequent growth have produced an elongated blastodisc.

The serial sections of this stage were cut transversely, each section passing through two blastomeres These cells are separated by a very fine membrane which extends deeply into the blastodisc, almost to the yolk. At the periphery of the blastodisc, the blastomeres continue into a progressively thinner layer of superficial protoplasm, which extends over the yolk. The zone of transition between the edge of the blastodisc and the superficial layer of protoplasm over the yolk constitutes the early periblastic ridge as described for *Serranus* by Wilson. The astral rays of the mitotic figures are very conspicuous, extending nearly to the boundaries of the cell. All eight cells are actively undergoing mitosis The planes of the spindles in various cells which are in the metaphase condition indicate that the succeeding or fourth cleavage furrow will be parallel to the second, as described above, and at right angles to the third This will produce four more or less distinct rows of cells and increase the breadth of the blastodisc, tending to restore its rounded outline, as in Fig. 4, Pl. I

All eight-celled blastodiscs are not elongated as described above, although probably about three out of every four eggs at this stage show this pattern Some were observed in which the blastodisc was distinctly circular and the cells were disposed symmetrically about a central point In these, it is assumed that the first two furrows had been meridional and at right angles to each other, but the third cleavage furrow was completely circular and located midway between the center and the periphery of the blastodisc This tendency of the third furrow to be circular is seen with all its modifications. Indeed, the third cleavage furrow in Fig. 1c, separating the third and fourth pairs of cells describes an arc of such a circle. It is well known that such variations in cleavage patterns are determined by varying rates of growth of the cells and by the relative pressures which they mutually exert upon one another. In eggs in which the cells are concentrically disposed, the fourth cleavage furrow is apparently meridional. The resulting cleavage pattern accompanied by some irregular growth of the cells is illustrated by Fig. 2, Pl. I.

In succeeding stages, the bilaterality of the blastodisc is no longer apparent. Fig. 3, Pl. I, is approaching the 32-celled

condition, and the blastodisc shows a decided tendency to become rounded up. By Stage No. 8, the blastodisc is completely rounded

Stage No 8. O. S. U. series—Incubation period, 2 days, 4 hours, 15 t. u. Transverse sections through this stage (see Fig. 8, Pl II) reveal that, while the cells of the blastoderm are comparatively large, they have been reduced through cleavage to about one-fourth the diameter of cells of Stage No. 1. The blastodisc is four cells deep through its center but shallower at its margins The cells at the surface are slightly broader than deep and closely joined at their edges, representing the initial stage in the formation of the epidermic stratum. The deeper lying cells are loosely arranged with spaces between them in the central portion of the blastodisc These scattered spaces represent the segmentation cavity of a type similar to that described by Kopsch ('04) for the trout, and differs from the single continuous ventral one as described by Wilson for the sea bass. The early periblastic ridge at the margin of the blastodisc is prominent The marginal blastomeres which form the ridge are prolonged into the protoplasm covering the yolk, to form the central periblast The latter is an extremely thin layer of protoplasm lying immediately beneath the blastodisc. It is not separated from it by the segmentation cavity as shown in Wilson's figures 17 and 18 of *Serranus.* The yolk mass underlying the central periblast at this stage contains many scattered, irregularly shaped darkly pigmented bodies or granules which may constitute a syncytium of yolk nuclei, but more probably they are simply yolk granules These are not to be confused with the syncytium of nuclei formed later in the central periblast from cells migrating inward from the periblastic ridge

Stage No. 16 O. S U. series—Incubation period 3 days, 12 hours, 30 t. u. The blastodisc is somewhat more prominently raised up on the yolk, and the outlines of the individual blastomeres are indistinct on the surface, owing to rapid cell division. Transverse sections of this stage, (Fig. 16, Pl. II) show the blastomeres reduced to about one-fourth their former diameter in Stage No. 8. They form a blastoderm of from eight to ten cells deep. The spaces of the segmentation cavity between cells are less conspicuous. The epidermic stratum which was forming in Stage No. 8 is clearly defined as a superficial layer of somewhat flattened cells. This stage corresponds closely to

that figured by Kopsch at the end of segmentation in the trout.

Stage No. 32. O. S. U. series—Incubation period, 6 days 4 hours, 42 t. u. *The formation of the germ ring and subgerminal cavity.* The egg is rapidly approaching the end of the segmentation phase of its development. Many more cells are now shown in a single cross section than in previous stages, there being as many as two hundred in sections through the center of the blastoderm. The cells are correspondingly smaller in diameter. Evidently segmentation is occurring rapidly. The blastoderm spreads out over the yolk surface more than in earlier stages, and accordingly it is thinner, being only from six to eight cells deep. The epidermic stratum is a clearly differentiated layer of cells at this stage

The periblastic wall contains clusters of nuclei of cells which have probably migrated into it from the margin of the blastoderm and subsequently lost their cell walls, in the manner described by Wilson, pp 216–217, for *Serranus*. These nuclei have reached the center of the periblast as indicated by their presence in that region. The central periblast is now a syncytium of scattered nuclei which continues uninterruptedly into the periblastic wall and the cortical protoplasm over the yolk. The early periblastic ridge has largely disappeared. The marginal cells of the blastoderm lying above the periblast are closely packed together to form a wreath-shaped thickening, the germ ring, which is clearly seen from surface views of whole mounts (see Fig. 32, Pl I). The blastoderm has become greatly arched over the curvature of the egg.

As a result, a single continuous segmentation or subgerminal cavity lies prominently between the central periblast and the overlying blastomeres, to one side of the center and just within the germ ring. This segmentation cavity is apparently formed here as a larger space than in the previous stage, simply as the result of the crowding of the cells at the periphery of the blastoderm. It is probably confluent with the smaller spaces scattered elsewhere between the cells of the cross section. If this be true, the isolated spaces in cross-sections of earlier stages may actually be confluent and thus be regarded as essentially homologous to this single continuous subgerminal cavity which arises at this stage. As the cells of the blastoderm are reduced in size through repeated divisions and crowded together by the overarching of the blastoderm, the spaces

between them are thereby diminished. These spaces are finally reduced to the vanishing point in cross-sections of the next stage, No. 48. The sole remaining space is a typical subgeminal cavity.

Stage No. 48—Incubation period, 8 days, 20 hours; 60 t. u.

The growth of the blastoderm; the primitive entoderm—The growth of the blastoderm around the yolk continues rapidly after the completion of the germ ring in the previous stage In the present stage, (see Fig. 48, Pl. I), the blastoderm envelops approximately one-third the yolk, and the germ ring is plainly visible at its periphery The subgerminal cavity appears from the surface view as a translucent, circular area within the cap of cells. In cross-sections, this cavity extends broadly beneath the blastoderm It has clearly defined limits which extend to the marginal cells of the germ ring from within. The blastoderm is more elevated above the periblast than in *Serranus*, but the marginal cells of the germ ring are similar to those in Wilson's figures 46 and 47, Pl. XCIV The subgerminal cavity is slightly eccentric, due to the rapid proliferation of cells on one side of the germ ring to form a deeper lying mass of undifferentiated cells, the embryonic bud. (See Fig. 48, Pl. II). In this area the cells are compact and the blastodisc is approximately twice as thick as elsewhere. The embryonic bud is destined to give rise to the embryonic shield and its posterior margin will constitute the dorsal lip of the future blastopore.

A tongue of primitive entoderm extends anteriorly from the embryonic bud toward the center of the blastoderm. At this stage, it reaches almost to that point. The periblastic layer has become fully developed, and retains the features described in the previous stage Throughout the remainder of the embryonic period, the periblast remains unmodified. as the covering of the yolk beneath the embryo.

Stage No. 64—Incubation period, 11 days, 12 hours, 82 t. u. The blastoderm is flattened out as a sheet of cells enveloping the upper half of the yolk sphere, with the germ ring lying in the equatorial plane. (See Fig. 64, Pl. I). In some whole mounts of this stage, the blastoderm is translucent, at least in the extra-embryonic portions and the yolk surface beneath is clearly visible. While the embryonic shield is hardly visible from surface views, cross-sections show that it is definitely established In the posterior end of the shield,

an undifferentiated caudal mass of cells arises abruptly, with its thickest portion in the axial line. Just anterior to the caudal mass, the shield extends laterally to end abruptly at its margins. In cross-sections at this level, (see Fig. 64, Pl. II), beneath the epidermic stratum lies the ectodermal layer, several cells deep, underlaid by a two-rowed cell layer of primitive entoderm. The entoderm extends forward as a tongue of cells, as described for the previous stage. No. 48, but now underlies the entire shield, thus obliterating the subgerminal cavity In the central axial portion, the entoderm from either side fuses into an undifferentiated line of cells, which represents the first step in the formation of the notochord As the anterior end of the embryonic shield, the two layers of the entoderm lose their identity and appear as a single layer which fuses with the overlying ectoderm, a condition which represents the first step in the formation of what Wilson termed the neurenteric streak (See Wilson, Fig. 52).

Stage No. 80—Incubation period, 14 days, 4 hours, 93 t. u. The embryonic shield becomes clearly visible on the whole mount at about Stage 72, but is figured for the first time in the drawing of this stage, Fig 80, Pl. I The somewhat triangular area represents the thickened embryonic portion of the blastoderm, in contrast with the lateral extra-embryonic portion which extends as a thin sheet of blastoderm over the curvature of the yolk to end in the germ ring at its margins. The bluntly rounded apex of the shield has extended forward from the condition described in Stage 64 and now clearly marks off the anterior end of the embryo

The so-called neurenteric streak, which was beginning to form in the previous stage, is now clearly visible from the surface view, as a median longitudinal opague area which extends from the anterior end of the embryonic shield backward to the notochord. It marks the location of the neural chord in the head end of the embryo.

From its incipient condition in Stage 64, the notochordal area has grown forward from the caudal mass and occupies the posterior third of the embryonic area It appears in surface views of whole mounts as a light streak in the axial line. It is still an undifferentiated cell mass, fused laterally with the entoderm

The extra-embryonic portion of the blastoderm extends laterally and anteriorly beyond the embryonic shield to the

germ ring as mentioned above, and it now encloses two-thirds of the yolk. In this extension of the blastoderm, the direction of growth is difficult to determine. There are no definitely placed oil globules as there are in *Serranus*, by which to judge the relative position of the germ ring. In *Serranus*, in *Salmo*, and in various other teleosts, it has been shown that the position of the caudal mass and hence that portion of the germ ring which constitutes the dorsal lip of the blastopore is relatively fixed In such cases, extension takes place by way of the anterior margin of the germ ring growing around the yolk. However, in *Hemichromis*, in which the egg is oblong, McEwen ('30) describes also a backward growth of the dorsal lip of the blastopore. Thus all portions of the germ ring take part in the closure of the blastopore by their migration toward the point of closure. In spite of Wilson's statement to the contrary, p 222, the posterior end of the sea bass embryo in his Fig 38, Pl XCII, is somewhat closer to the oil globule than it is in his Fig. 36 of an earlier stage. The difference is not marked however. Thus there is some backward growth of the dorsal lip of the blastopore, although it is slight in comparison to the migration of the anterior margin of the germ ring over more than half the yolk surface to finally meet the dorsal lip at the point of closure In the Whitefish, the closure of the blastopore occurs in much the same way as in *Serranus*, involving mostly epiboly of the anterior or ventral lip, supplemented by some concrescence and by a slight backward growth of the dorsal lip.

Stage No 96—Incubation period, 16 days, 20 hours, 97 t u. This stage is marked by the further growth of the blastoderm around the yolk, advancing to a *large yolk plug stage*. The embryonic shield has increased to 2.0 mm. in length This increase in length is due partly at least to a slight backward extension brought about by a concrescence of the lateral lips of the blastopore. The line of this concrecence would correspond to the primitive streak of other forms and is marked by a thickened mass of cells referred to in Fig 96b , Pl. II, as the caudal mass. Kupffer's vesicle is seen for the first time in this stage. It appears on the floor of the caudal mass Its walls are formed by a single layer of regularly arranged cells Just anterior to this vesicle, the notochord arises, possessing a distinct outline and a compact shape. Its anterior end extends two-thirds the distance from the caudal mass to the anterior

end of the embryo. The lateral mesodermal plates are now readily distinguished from the surface ectoderm dorsally, from the notochordal area medially and from the entodermal cells ventrally (See Fig. 96c. Pl. II). The ectoderm is now greatly thickened over the entire embryonic shield, as compared to the extra-embryonic portion. In the anterior end of the embryonic area, this ectodermal thickening is very marked, forming the neural keel. Above it, dorsally, a shallow median neural furrow appears, into which dips the epidermic stratum. This furrow is transitory, and disappears in a slightly later stage, No. 112. At this level the primitive entoderm forms a single cell layer beneath the neural keel.

Stage No. 112—Incubation period, 19 days, 12 hours, 103 t. u. Length of embryo: 2.32 mm. (See Fig. 112, Pl. I and II). By this stage, the neural keel has undergone a marked downward growth into the yolk mass. As it continues to thicken and grow deeper, the lateral portions of the neural keel grow thinner, as the result, according to Wilson, of cell migration. Thus in surface views the so-called neurenteric streak of the embryo projects anteriorly from the original dorsal lip of the blastopore as a long narrow opaque area on the surface of the yolk, of almost uniform width throughout its length, but with greater depth at the anterior end. The neural furrow, mentioned in the previous stage, is shown in the surface view here, but it disappears with this stage. It fades out progressively from behind forward. The cells of the neural keel are the same in appearance throughout, not yet being stratified nor differentiated. The optic primordia make their first appearance at this time, as solid cell masses.

The outline of the notochord is visible from the surface view. Its anterior end extends two-thirds the distance from the caudal mass to the anterior end of the embryo. In the posterior region, its cells are rounded up and may be easily distinguished from the nerve cord, the mesodermal masses, but somewhat less distinctly from the entoderm. Farther forward, however, it is progressively less differentiated. The mesodermal plates, described in Stage 96 as having separated from the adjacent layers, are now divided into two parts: the one more mesial which later forms the dorsal mesodermal plates; and the outer part, which later forms the lateral mesoderm, the intermediate cell mass and its derivatives, and the Wolffian ducts. (See Fig. 112, Pl. II; also, Swaen and Brachet,

Fig. 66, Vol. 16, '00). In the middle region of the embryo, the dorsal mesoderm is for the first time composed of a solid rosette of cells which represents the somite. There are apparently three pairs of somites present at this stage. The lateral mesoderm is likewise a solid mass of cells. On its mesial border is a single line of cells which later splits off from the remainder of the mass to form the intermediate cell mass. At the level of the somites, the entoderm lies over the periblast as an unfolded sheet of cells, one layer thick. This stage is distinguished by the *narrow yolk plug*. The blastopore is almost closed at this time.

Stage No. 128—Incubation period, 22 days, 4 hours; 108 t. u. Total length of embryo: 2.96 mm.; eleven pairs of somites; closure of the blastopore. In contrast to the previously described stage, very marked cephalization has occurred at this time, as seen in both the surface view drawing, Fig 128, Pl. I, and in the reconstruction drawing of this stage (Fig. 128, Pl. II). Three primary cerebral vesicles have developed. The neural keel in the head region has continued its downward growth and lies half imbedded in the yolk. Its depth in the brain-forming region is at least twice that of its depth in the middle portion of the spinal cord region of the embryo There are no cerebral ventricles present at this stage however, and the optic outgrowths are still solid cell masses. The cells of the neural keel are no longer indifferently placed, but are becoming rearranged into two parallel rows which separate in Stage 144, to form the cavity of the neural canal. This rearrangement of cells takes place first in the prosencephalon and continues backward to the middle region of the neural cord. The optic anlagen which appeared in Stage 112 have greatly enlarged, and in the reconstruction drawing are shown as projecting prominently from the sides of the prosencephalon. They are now separated externally from the brain by a fissure which appeared in Stage 120 and which now extends from above downwards and from behind forwards, leaving only the ventral portion connected with the prosencephalon. This connection is the optic stalk.

Immediately posterior to the anlage of the eye is a mass of head mesoderm, of mesenchymatous appearance. While it appears here as a distinct mass, its later disposition has not been thoroughly traced. There is but little evidence of the existence later of head somites, and none of segmentally arranged

head cavities. A wing of lateral mesoderm extends along the sides of the body from the anterior end of the paired somites at the level of the rhombencephalon forward to the middle portion of the head region. It spreads out laterally on the yolk surface, but since the keel sinks so deeply into the yolk, the mesoderm appears high on the side of the head. A longitudinal furrow appears in this same region on the dorso-lateral surface of the head at the angle between the neural keel and lateral mesoderm. It is probably the so-called sensory furrow described by Wilson in *Serranus*, and as such is the anlagen of the auditory pit and lateral line sense organs

The notochord anterior to the caudal mass is two or three cells deep Its cells are interlocked and are approaching a period when their vacuolation begins. Anteriorly the notochord is clearly separated from adjacent areas. It extends with the flattened layer of entoderm beneath it forward to the level of the midbrain. This position is retained hereafter

Eleven pairs of mesodermal somites are present, as shown in the drawing Kupffer's vesicle, which appeared in Stage 96, has now reached its maximum development in the floor of the caudal mass, and from this time on, it begins to diminish in size. The blastopore is completely closed over on the surface, and its position is marked by a narrow indentation or furrow in the tail region

SUMMARY

From the foregoing descriptions, it is seen that the Whitefish, in its early development up to the closure of the blastopore, is typically teleostean The 3 mm egg with its capsule, perivitelline space, and the concentration of oil globules at the animal pole agrees closely with eggs of other species, although a micropyle is apparently absent The formation of the blastodisc and the cleavage of the blastomeres follows closely the pattern described by other writers for the trout, the sea bass, and other species, and may be regarded as typical of telolecithal eggs The early segmentation cavity, by virtue of the fact that it is interspersed between scattered cells of the blastoderm, resembles that of the trout, but differs from that of *Serranus* It may probably be regarded as a characteristic of the Isospondyli.

The growth of the blastoderm over the yolk, the formation of the germ ring, the periblast and the primitive entoderm,

the delineation of the embryonic shield and within it, the differentiation of the three primary germ layers, all proceed in much the same manner as previously described for other Teleosts

However, the relative degree of development attained by the whitefish at the time of the closure of the blastopore is of special interest. In this series, this event has occurred by Stage 128, when these eggs have been incubated for 22 days and have been subjected to 108 thermal units. In terms of days, these eggs have completed just ⅙ of their incubation period, but ⅓ of the incubation period in terms of thermal units The higher proportion of the latter is due to the fact that, during the first part of the incubation period, the temperature of the lake water is comparatively high, and the ratio of thermal units to days is consequently higher than later in the season, when the daily temperatures descend to around 33° F It is seen then that the blastopore closes within the first sixth of the incubation period in point of time and within the first third of this total period on the basis of both time and temperature (thermal units). At this stage, the embryo is clearly outlined, lying in a straight line over the curvature of the egg, with a length of about 3 mm., which is just one-fourth its hatching length Within the body of the embryo, all three primary germ layers have undergone considerable differentiation Derived from the ectoderm, the three primary brain lobes are distinct, and the neural keel lies deeply imbedded in the yolk. The optic primordia are now borne on broad optic stalks The mesoderm has given rise to a mass of head mesoderm, to the notochord which now extends forward its full length to end beneath the midbrain, and to eleven pairs of somites, or about ⅙ of the hatching number Kupffers' vesicle has reached its maximum development The entoderm is undergoing rapid changes, preparatory to the development of branchial pouches.

When compared with other species of teleosts whose embryology has been studied, it is seen from the above items that the whitefish is notably well differentiated at the closure of the blastopore.

It now remains for later papers of this series to outline the embryology of the whitefish during the remainder of the incubation period, subsequent to the closure of the blastopore.

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LIST OF ABBREVIATIONS USED IN THE FOLLOWING PLATES

b. d —blastoderm
Bl —blastopore.
c. m.—caudal mass.
c. p.—central periblast
d. mes.—dorsal mesodermal plate.
ecto —ectoderm.
e e s —edge of embryonic shield.
em. bd —embryonic bud
ento.—entoderm
ep.—epiblast
e. s.—egg shell or membrane
e. p r —early periblastic ridge
ep. str —epidermic stratum.
g. r.—germ ring
hd mes.—head mesodermal mass
i. c m.—intermediate cell mass
K. v.—Kupffer's vesicle.
lat. mes —lateral mesoderm
mes.—mesoderm.
Mesen —mesencephalon.
n f —neural furrow.
noto.—notochord
n. s —neurenteric streak.
o. g.—oil globule.
op prim —optic primordium.
op st —optic stalk.
P —periblast.
pr ento.—primitive entoderm.
Prosen —prosencephalon
p v s.—perivitelline space
Rhomb.—rhombencephalon.
s c.—segmentation cavity.
s f —sensory furrow.
s g c.—subgerminal cavity
som XI—somite eleven.
y —yolk
y g.—yolk granule.
y. m —yolk mass.

EXPLANATION OF PLATES

(Figure numbers correspond to the serial stage number from which they are taken.)

PLATE I

Fig. 1a. Unfertilized egg, with animal pole uppermost

Fig 1b. Four-celled stage, 3 hours after fertilization

Fig. 1c Blastodisc of about 8 cells, from above

Figs. 2, 3, 4. Early segmentation stages, 16–32 cells

Figs. 8, 16, 32. Later segmentation stages.

Figs 48, 64 Formation of germ ring, and growth of blastoderm

Fig. 80. Showing embryonic shield, neurenteric streak, blastopore.

Fig 96. Large yolk plug stage, showing outlines of early embryo

Fig 112. Narrow yolk plug stage.

Fig 128 Closure of the blastopore. Three primary brain lobes.

Figs. 144, 160 Surface views of subsequent development

PLATE II

Fig 8. Cross-section through center of blastodisc of Stage 8 (Drawn from slide B, first row, third section of serial mounts in O S. U. series. Similar code is used to designate drawings of sections of other stages.) Shows early segmentation cavity, and early periblastic ridge.

Figs. 16, 32, 48 Cross-section of corresponding stages shown in Plate I, showing formation of subgerminal cavity.

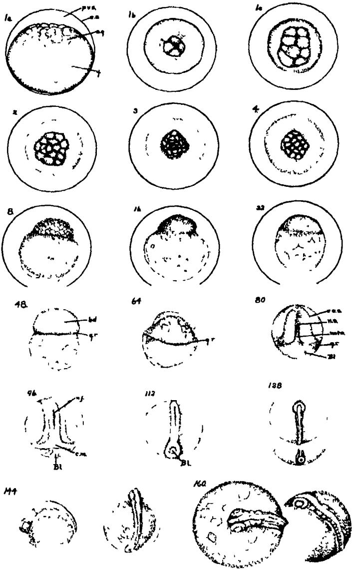
Fig 64 Cross-section through one side of embryonic shield, showing an undifferentiated notochordal area in mid-ventral line.

Fig 96 B Cross-section cut obliquely through dorsal lip of blastopore, showing Kuppfer's vesicle, and the differentiation of notochordal tissue anterior to caudal mass

Fig. 96 C Cross-section more anterior than 96 B. The primitive entodermal layers are definitely separated into single layers of mesoderm and entoderm.

Fig 112 Cross-section through dorsal mesodermal plate.

Stage 128, Reconstruction drawing, showing embryo in natural position over curvature of the yolk. This stage marks the closure of the blastopore


1a
p.v.s.
e.a.
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y
1b
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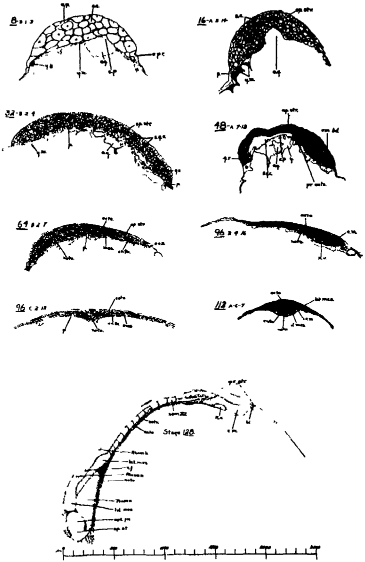
Stage 128

DUPLICATE EVOLUTION OF PECULIAR PERIANTH STRUCTURES IN THE SEDGE FAMILY AND THE COMPOSITES

Studies in Determinate Evolution, VIII[1]

JOHN H. SCHAFFNER

It is not at all surprising to find similarity of structures and parts in closely related forms. Such similarities are at present usually taken for granted because we know that segregative evolutionary movements, although they establish barriers beyond which no further evolution is possible, do not prevent progressive changes of a parallel nature in the segregated groups. Thus two related groups may evolve series of almost identical characters. In the past, such duplicate developments have often been described as examples of mimicry. But the old teleological hypothesis of mimicry, as developed by the followers of Darwin, is almost entirely a figment of a very vivid imagination and very commonly was based on the most ridiculous propositions and fancies. No one without a very enthusiastic credulity would at present attempt to maintain such fantastic explanations of biological phenomena except those to whom teleological theories are a sort of confession of faith handed down from a former generation of teleologists, who could not conceive of any biological structure except in terms of some special advantage or use which would preserve the individual in an unfortunate and cruel world, where tooth and claw, heat and cold, and the like determined the whole course and direction of evolution.

In the present paper is presented a series of remarkable, parallel developments from two groups of plants which are not only widely separated in relationship but exist in very different environments. The species of the sedge family represented are mostly hydrophytes, some growing as partially submerged aquatics and others in moist or wet habitats, while those of the composite series are nearly all mesophytes, some of them growing in quite dry soils. Both groups are far advanced along evolutionary lines and far removed from any past connecting links. The sedges are monocotyls with closed vascular

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bundles, parallel-veined leaves, and trimerous, hypogynous flowers, while the composites are dicotyls with open vascular bundles, netted-veined leaves, and pentamerous, epigynous flowers.

The primitive type of flower of the sedges has a dicyclic, trimerous perianth. In the species of Oreobolus the perianth segments are all broad and resemble somewhat the sepals and petals of a Juncus. From this condition there is a gradual modification and reduction until in the extreme forms there is no vestige of a perianth left In Figure 1 is represented a mature flower of *Fuirena hispida* Ell. The three petals are stalked and have broad blades with forwardly projecting barbs, but the sepals are reduced to bristles with backwardly projecting barbs. In the genus Scirpus, the perianth is reduced so much that all the segments, whether representing sepals or petals, are reduced to bristles. These bristles are attached to the base of the achene when it is shed. In some of the species the bristles have no barbs whatever, as in *Scirpus caespitosus* L. (Fig. 2). The plant is entirely indifferent in this respect. In *Scirpus cyperinus* (L.) Kunth. (Fig 3), the bristles are also destitute of barbs, but a new factor causes them to be developed as long and flexible hairs, which are responsible for the plants common name "Wool-grass." Many of the higher species of Scirpus have developed barbs on the perianth bristles. In *Scirpus americanus* Pers the perianth bristles have very prominent, retrorse barbs (Fig. 4). *Scirpus planifolius* Muhl. (Fig. 5) has outwardly projecting barbs on the perianth bristles. Thus of these four species of Scirpus, two are indifferent as to barbs, one has retrorse barbs and can thus hold on to things while the other has forwardly projecting barbs which prevent the bristles from being attached to objects. All three types of perianth bristles, non-barbed, forwardly barbed, and retrorsely barbed, are also found in species of Rhynchospora and Eleocharis, although in the latter genus the bristles are mostly retrorsely barbed. All types exist in the same ecological conditions and it is evident that the different types did not originate through the direct influence of the environment nor through a life and death struggle for existence in the environment. All are successful. Any teleological explanation would be a mere fairy tale.

Turning now to the composites which show similar developments, and which have been used extensively by teleological

biologists to prove their case, we find a strikingly parallel series in the genus, Bidens, only in this case the calyx alone is involved, the corolla continuing as a normal structure. *Bidens tereticaulis* D. C. (Fig 14) has entirely smooth sepal awns corresponding to the bristles of *Scirpus caespitosus* L. It is also entirely indifferent as to whether it is to catch on to anything or not. But *Bidens frondosa* L (Fig. 13) has prominently retrorsely barbed sepal awns which are able to catch on to the fur of various animals Thus the seed may be carried far from the paternal aeres and perhaps deposited in very sterile or unfavorable soil. Various other species of Bidens have these retrorsely barbed awns or bristles, one of the commonest being *Bidens bipinnata* L , the Spanish-needles Now in *Bidens bidentoides* (Nutt.) Britt. (Fig. 12) the sepal awns are again outwardly barbed as in *Scirpus planifolius* Muhl

It will be seen that in each of these two genera the awns or bristles have evolved all the possibilities in respect to the presence and position of barbs and the species of the several types are often found growing side by side in the same locality and in the same habitat, those of Scirpus in hydrophytic conditions, those of Bidens in ordinary mesophytic fields or waste places There is neither an advantage nor a disadvantage in having barbs or in not having them, nor does it make any difference to the plant in its survival or in its ability to be distributed whether the barbs project forward or backward All the multitude of articles and books which have dilated on the advantage to the species of being widely distributed through such means are based on imaginary presumptions We might just as well presume that any plant was at a disadvantage in possessing special structures which would facilitate removal from its original favorable habitat There are genera in both the Cyperaceae and in the Helianthaceae which have no special structures whatever for distribution which are among our most widely distributed plants In Cyperus the perianth is entirely absent and the achene has no appendages whatever. In *Anthemis cotula* L. and *Chrysanthemum leucanthemum* L. the achenes have no pappus bristles nor any other kind of appendage, but just as in the case of various species of Cyperus, they are among the most widely dispersed species in the world. The notion developed in the past and for a time held as a fundamental principle of biology, written into almost every elementary text-book of botany and nature study, that these

special structures were evolved through a life and death struggle for existence or as a result of the direct influence of environment is highly irrational and is evidence of an extreme credulity in the scientists of the past generation.

As noted above, *Scirpus cyperinus* (L.) Kunth. has evolved its six perianth segments into long flexible threads. This change of perianth segments to long thread-like structures has been highly evolved in the genus, Eriophorum The species of Eriophorum form a prominent orthogenetic series in this respect. In *Eriophorum alpinum* L. (Fig 6) there are only the six original perianth segments in the flower, but these are greatly elongated. In Figure 6 the perianth hairs are represented one-half their comparative length From this condition the various species represent a series in which the perianth cycle consists of a greater and greater number of pappus hairs until a very extreme condition is reached in *Eriophorum viridicarinatum* (Engelm) Fern which has about 70 pappus hairs (Fig 7)

Passing from these bog plants to the dry land plants of the composites, one is again impressed by the remarkable similarity in the evolutionary development Among numerous genera that might be taken to represent a condition corresponding to *Eriophorum alpinum* L , *Elephantopus tomentosus* L. shows a close parallel (Fig 8) There are five sepal bristles, the petals not being affected as they are in Eriophorum These bristles have flat bases but are very slender toward the top In *Elephantopus spicatus* Aubl (Figs 9a, 9b), a Guatemalan plant, the pappus bristles have a very peculiar character in that each one has a characteristic double fold toward the outer end. This is one of those oddities which one finds when approaching the extreme limits of most of the higher phylogenetic series. That the Guatemalan climate or politics has nothing to do with this remarkable oddity is shown by the fact that *Elephantopus scaber* L., another Guatemalan species, has straight bristles like our own *Elephantopus tomentosus* L and *Elephantopus carolinianus* Willd.

In some composites there is a double whorl of pappus scales. Thus in *Cymbia occidentalis* (Nutt) Standley, a dry prairie plant, there are five flat scale-like sepals and five extra bristles at the angles, making an inner series and indicating that multiplication of the pappus units has begun (Fig 10). This double series of broad scales and slender bristles simulates such

forms as *Fuirena hispida* Ell. In both the Helianthaceae and Cichoriaceae there are many series ending in numerous pappus bristles. The ultimate members of each series have no direct relation to each other but were evolved through a series of steps from more simple ancestral types Figure 11 represents an achene of *Lactuca villosa* Jacq. whose numerous pappus bristles show an extreme evolution from the original and simple five sepals, as those of *Eriophorum viridicarinatum* (Engelm) Fern. show an extreme development from the original six-parted perianth.

At present it is probably useless to speculate on the cause of the remarkable parallelism shown in the evolution of the pappus bristles of two groups so distant in relationship and so diverse in habitat as species of Eriophorum and the Cichoriaceae. It is sufficient to note the fact that such developments are very commonly the accompaniments of extreme reductions and attenuations in structures that were originally much more normal organ systems There are many other extreme groups which show such structures Very remarkable are the pappus developments in various species of Eriocaulon and Lachnocaulon, which genera are among the most extreme in the Liliales series, having heads of small flowers with involucres simulating closely the heads of many Compositales In some species the sepals show some transformation into clusters of hairs but the most striking examples are represented by species like *Eriocaulon griseum* Koern. in which, in the carpellate flower, both the sepals and petals have been greatly reduced and transformed into numerous pappus bristles quite similar to those in Eriophorum and Lactuca. The three sepals in this species are, however, still distinct broad structures but with short hairs at the outer tips. In the closely related *Lachnocaulon anceps* (Walt.) Mor the space representing the petal cycle is also occupied by copious, woolly hairs between the three sepals and the ovulary. In each of these genera a long orthogenetic series of more and more advanced developments in respect to pappus development is also in evidence.

Among the Valerianaceae, *Valeriana pauciflora* Mx. and *Valeriana edulis* Nutt. develop calyx pappus bristles much like some of their distant relatives in the Compositales and the same is true of *Scabiosa arvensis* L. among the Dipsacaceae. In the highest Pandanales, as in species of Typha, the extremely reduced carpellate flowers develop abundant long hairs on the

pedicels while their near relatives, the Sparganiaceae, considerably lower in the evolutionary series in nearly every respect, have small perianth segments and no bristles in or below the carpellate flowers. In a general sense the same is true in the higher grasses, where bristles and plumes are very prominent in such highly evolved tribes as the Agrostideae, Paniceae, and Andropogoneae. Among the extreme forms of the Paniceae, like species of Chaetochloa, and related genera, special bristles, some retrorsely barbed and some forwardly barbed and also giving orthogenetic series of greater and greater numbers of cortical bristles around the groups of spikelets, are very prominently developed but are not connected directly with the floral structures and so remain on the dead stalks after the fruits have been shed. In the Andropogoneae, the most extreme tribe of the grass family, bristles and large hairs are often very prominent features of the extremely reduced spikelets, giving rise to the popular names, beard-grass, wool-grass and plume-grass commonly applied to these plants.

All of these developments are to be regarded as the outcome of extreme evolutionary movements which have no relation to a supposed response to environment since they occur in the most diverse environments and circumstances, and in the most diverse morphological systems. Nor, as stated, do they have any relation to utility, for frequently they are so situated that they cannot become a part of the distributional mechanism. Even if they are a permanent part of the fruit and thus accomplish wide distribution through the agency of wind or animals, they are, nevertheless, not at all to be regarded in any special or teleological sense as being produced because of a special utility, since, as shown above, species without any devices whatever for distribution are just as successful and often more so and are able to be just as widely distributed as those which have the special structures as extreme over-adaptations

These studies again show that even the so-called ecological adaptations may have no relation to special environments, that the most diverse structures occur in the same environment, and that the same structures evolve in very diverse environments. They indicate that evolution is kinetic, orthogenetic, and determinative, and that these remarkable progressions are conditioned by internal causes.

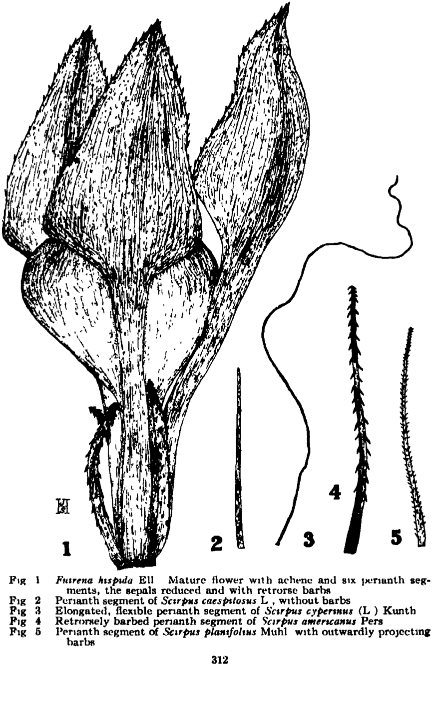
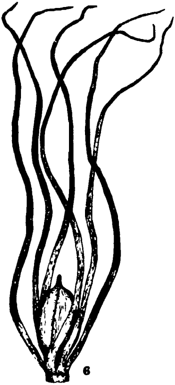


Fig 1 *Fuirena hispida* Ell Mature flower with achene and six perianth segments, the sepals reduced and with retrorse barbs
Fig 2 Perianth segment of *Scirpus caespitosus* L , without barbs
Fig 3 Elongated, flexible perianth segment of *Scirpus cyperinus* (L) Kunth
Fig 4 Retrorsely barbed perianth segment of *Scirpus americanus* Pers
Fig 5 Perianth segment of *Scirpus planifolius* Muhl with outwardly projecting barbs



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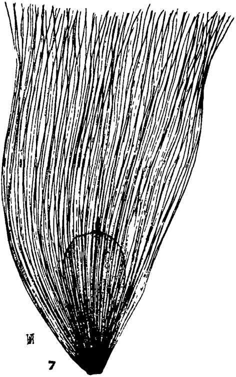

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Fig 6 Flower of *Eriophorum alpinum* L., with the six elongated perianth segments represented half the comparative length.

Fig 7 Achene of *Eriophorum viridicarinatum* (Engelm.) Fern., showing the original six perianth segments replaced by about 70 slender bristles, which are represented one-half their comparative length.

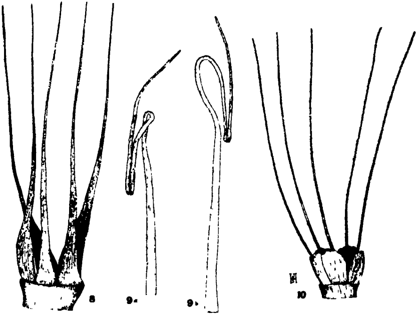

Fig. 8 Pappus of *Elephantopus tomentosus* L., showing the five elongated calyx segments.

Figs 9a, 9b Pappus segments of *Elephantopus spicatus* Aubl., showing a peculiar double fold toward the outer end

Fig. 10. Double pappus of *Cymbia occidentalis* (Nutt.) Standley, showing five short flat scales and five long bristles

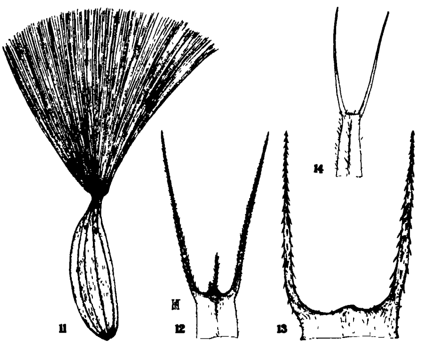

Fig. 11. Achene of *Lactuca villosa* Jacq., showing the very numerous pappus bristles

Fig. 12. Outwardly barbed pappus awns of *Bidens bidentoides* (Nutt.) Britt.

Fig. 13. Retrorsely barbed pappus awns of *Bidens frondosa* L.

Fig. 14. Awns without barbs of *Bidens tereticaulis* DC.

ADDITIONS TO NORTH AMERICAN FRESH-WATER BRYOZOA

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Two summers of intensive collecting for Bryozoa on and around twenty islands and localities in southwestern Lake Erie resulted in the addition of nine forms to the seven already known from Lake Erie and the addition of several forms to the North American list At the present time there are approximately 21 species and varieties of freshwater Bryozoa known from North America - sixteen of which are represented in Lake Erie Nine of the twenty islands from which collections were taken are Canadian possessions

Specimens of *L carteri* var *typica* from Lake Erie were sent to the U S. National Museum on March 6, 1934, and entered in their records as No 128395

I respectfully submit the following corrections to Dr. Dahlgren's account.

1. Carter had colonies as well as a statoblast from which to make his observations He commented on the fact that this form resembled *Lophopus*, that the coenoecia exhibited movement and that the ectocyst was difficult to follow, etc. Carter, 1859, Ann Mag Nat Hist., (3) *III*: 341
2. Hyatt in *1866* recognized it as a new species and called it *Pectinatella Carteri* instead of *Lophodella carterii* Hyatt, 1866, Proc Essex Inst, vol *IV:* 203 (Comm)
3. Hyatt's designation as *P Carteri* was still used in 1885 Jullien, 1885, "Monographie, etc.," Bull Soc Zool France, *X*.
4. The genus *Lophopodella* (not *Lophodella*) into which *carteri* is now usually placed, was erected by Rousselet in 1904. Rousselet, 1904, Jour Quck Micr Club, (2) *IX:* 45–56, April, 1904.
5. Oka in 1906 discussed *P. davenporti* (Zool. Rec vol *XLV*, 1908). This form is classed as another variety of *L. carteri*, var. *davenportii* (Hastings, 1929, Ann. Mag. Nat Hist (10) *III:* 305.

6. The citation "*Ulman* in 1907 from equatorial Africa" possibly refers to *Ulmer*, 1912, Wiss. Ergebnisse d Deutsch Zentral-Afrika Exp. 1907-8, Band *IV:* 285-290.

TABLE I

THE DISTRIBUTION OF THOSE BRYOZOA WHICH WERE COLLECTED IN LAKE ERIE

	Form	Lake Erie: Present Record	Lake Erie: Previous Record	North America: Present Record	North America: Previous Record	World Distribution
	URNATELLIDAE					
1	*Urnatella gracilis.*	x	0	x	x	0
	PALUDICELLIDAE					
2	*Paludicella articulata*	x	0	x	x	Cosmopolitan
	PLUMATELLIDAE					
	FREDERICELLINAE					
3	*Fredericella sultana*	x	x	x	x	Cosmopolitan
	PLUMATELLINAE					
	Plumatella repens		x		x	
4	phase *alpha*	x	0	x	0	European
5	phase *beta*	x	0	x	0	European
6	var *emarginata*	x	x	x	x	Cosmopolitan
7	var *fruticosa*	x	x	x	x	European, Asiatic
8	var. *furcifer*	x	0	x	0	European
9	var *appressa*	x	0	x	x	European
10	var *jugalis* .	x	0	x	0	European
11	var. *flabellum*	x	0	x	0	European
12	*Hyalinella punctata*	x	x	x	x	Cosmopolitan
	CRISTATELLIDAE					Status of varieties an unsettled question among workers
	CRISTATELLA MUCEDO					
13	var. *idae*	x	0	x	x	
14	var *genuina* .	0	x	0	x	
	LOPHOPODIDAE					
15	*Lophopodella carteri* var *typica*	x	0	x	*	Asiatic, African (?)
16	*Pectinatella magnifica*	x	x	x	x	European

*Dr. Ulric Dahlgren, of Princeton University, in a recent issue of *Science* (Vol. 79, No 2057, p. 510, June 1, 1934) reported the occurrence of "Lophodella carterii Hyatt 1881" in North America. This is undoubtedly the same form as that which I have listed as var *typica* in an article entitled "Studies on Freshwater Bryozoa. 1 The Occurrence of *Lophopodella carteri* (Hyatt) in North America," which was accepted in January, 1934, for publication by the Transactions of the American Microscopical Society and which is scheduled to appear in the October (1934) issue of the Transactions

STUDIES IN THE BIOLOGY OF THE LEECH. III

THE INFLUENCES OF CHANGE IN TEMPERATURE UPON LOCOMOTION

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FORWARD LOCOMOTION

Locomotion in the leech may be differentiated into the following types: First, movements of reptation, i.e., the elongation and shortening of different somites This includes normal creeping or crawling movements, and looping. Second, movements of undulation as expressed in swimming.

A. MOVEMENTS OF REPTATION

True reptation is accomplished by the contraction of the circular muscles followed by a contraction of the longitudinal muscles. In forward locomotion, by reptation, a wave of contraction of the circular muscles originating in the anterior somites travels posteriorly. This results in the elongation of the animal and a subsequenct head movement forward. At this point the anterior sucker usually becomes attached. Following this initial wave of contraction is a corresponding contraction of the longitudinal muscles This later contraction results in the shortening of the animal. The posterior sucker remains attached throughout the period of extension while the anterior sucker becomes attached during the period of shortening. The suckers are primarily organs of fixation but function in normal crawling and looping.

Looping movements are a modification of the movements of true reptation. These movements consist of the normal elongation of the animal followed by a contraction during which the anterior and posterior suckers are brought close together. This movement resembles that of the measuring worm. In this movement the ventral longitudinal muscles play an important role.

It is axiomatic that the nervous system plays an essential part in the process of locomotion. The sequence of muscle

contraction in the earthworm during locomotion has previously been described, (Bovard, 1918).

The question which we desire to raise next is; what is the relationship in the leech between the neuro-muscular system and the stimuli that will produce a specific mode or rate of response?

The Influence of Change in Temperature Upon Locomotion

It is well known that the type of behavior expressed by certain animals may be conditioned by temperature. It is further evident that the rate of activity is, within limits, proportional to the temperature. D F. Miller (1929), clearly demonstrated the relation of temperature to the activity of fly larvae He found that the rate of locomotion varied directly with the temperature from 2° C., to 40° C., and inversely with the temperature above that point. Further that the rate of contraction increases directly with the temperature between 0° C., and 45° C.

Of the factors influencing locomotion in the leech temperature is the most obvious. With a constant light source and with the leeches partially immersed in water a series of tests were made to determine the influence of temperature changes upon locomotion. Temperatures ranging from 15° C., to 35° C., were used. Below 15° C., normal crawling could not be recorded accurately, while above 35° C., forward locomotion by crawling could not be induced. Beyond this temperature swimming movements replaced normal crawling. The accompanying tables will illustrate the results of these experiments.

The effects of temperature-change, upon the number of extensions is illustrated in Table I, column 2. It should be noted that, the number of extensions increases gradually as the temperature rises from 15° C., to 25° C., but that within the rise through the next 3° C., the number of extensions nearly doubles. In the last 7° C , increase in temperature there is a gradual increase in the number of extensions.

The average length of one extension through a temperature range of from 15° C., to 35° C., is shown in Table I, column 3. The average length of one extension increases as the temperature increases to 25° C. Further temperature increase results in a rapid decrease in the average length of extension.

The effect of temperature change upon the "rate" of locomotion in the leech is shown in Table I, column 4. The number of centimeters traveled per. second increases as the temperature approaches 28° C., after which the speed of locomotion decreases

Comparing these experiments on the leech with those on the earthworm I find that the two animals yield nearly the same results.

TABLE I

Temperature ° C.	Number of Extensions Per Second	Average Length of Extension in cm	Centimeters Per Second
15	26	1 7	442
18	28	1 9	532
20	29	2 2	638
22	31	2 6	806
25	34	3 2	1 088
28	51	2 4	1 224
30	57	2 0	1 140
33	60	1 8	1 080
35	63	1 7	1 071

B UNDULATORY AND SWIMMING MOVEMENTS

Undulatory movements are common to all leeches In some these movements are more pronounced than in others In Haemopis marmoratis (Say) this type of movement is frequently expressed. These movements have been variously described, as respiratory and excretory So far as I have been able to determine no connection between these so-called "causal movements" and the movements themselves exists

For convenience of reference I have differentiated between rhythmic movements which result in locomotion, designated, as swimming movements, and movements which occur while the leech is attached posteriorly, designated, as undulatory movements. These two expressions of behavior are fundamentally the same and differ in the rate of contraction depending on the type and intensity of the stimuli

Either undulatory or swimming movements may be instigated by any one of a variety or combination of stimuli. Those environmental stimuli which proved most successful were: changes in temperature; changes in dissolved oxygen and free carbon-dioxide; mechanical, electrical and chemical changes. Water currents (mechanical) also stimulated rhythmic movements

TABLE II

Temperature °C	Number of Undulations in Swimming per min	Number of Undulations while Attached per min.
10	0	30
12 5	0	33
15	72	35
17 5	76	37
20	80	40
22 5	85	45
25	91	52
27 5	97	68
30	104	86
32 5	115	0
35	130	0
37 5	175	0

Under experimental conditions it is possible to demonstrate that the rate of undulation and swimming movements may be controlled by regulating the temperature (see Table II). A series of experiments in which the dissolved oxygen and free carbon-dioxide content was varied (at a constant temperature of 25° C), clearly demonstrated that the rate of undulation is not dependent upon the gaseous concentrations in the water but that a change in concentration of dissolved oxygen or free carbon-dioxide may initate undulations. At low temperatures (below 15° C ,) undulatory movements predominate, while at high temperatures (above 30° C.,) swimming movements predominate. Temperature at these critical points is a direct factor in determining the type of behavior expressed.

The leeches were placed in a large shallow container which was partly filled with water. This container was immersed in a water bath, the temperature being regulated from the outside. Leeches were first exposed to low temperatures and gradually to higher temperatures Coordinated movements are replaced by spasmodic contractions as the temperature rises above 35° C

Table II, gives a comparison of the undulatory and swimming rate at different temperatures. This series of tests employed a range in temperature of from 15° C, to the lethal temperature of 42° C.

Conclusions

A

1. As the temperature increases between 15° C, and 35° C., the number of forward extensions increases.
2. The average length of extension increases between 15° C, and 25° C., after which further increase in temperature results in a decrease in the length of extension.
3. The rate of crawl increases with a temperature increase to 28°C., beyond which the rate of crawl decreases.
4. Swimming movements replace crawling as the temperature is increased above 30° C.

B

1. The rate of undulation and contraction increases with the increase in temperature from 10° C., to 37 5° C.
2. Undulatory movements normally occur at lower temperatures than swimming movements
3. Undulatory movements are replaced by swimming movements as the temperature is increased above 30° C.
4. Since either undulation or swimming may occur between 15° C, and 30° C, some, at present, unknown factor may determine which form of activity is expressed.

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THE OEDOGONIACEAE

Supplementary Paper Number One

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Further study of collections of Oedogonium and Bulbochaete from various parts of the world since the publication of the author's Monograph [1] seems to warrant the recognition of additional distinct species in the two genera In subsequent supplements to the Monograph it is proposed to use the following new names and new combinations as definite species

BULBOCHAETE Agardh 1817

1 **B robusta** (Hirn) Tiffany n comb

B monile Wittr & Lund var *robusta* Hirn Mon [2] p 30 Fig 73

2 **B scrobiculata** Tiffany n comb

B elatior Pringsh var *scrobiculata* Tiffany Mon p 33 fig 3

3 **B woronichini** Tiffany n nom

B brebissonii Kuetz var *minor* Woronichin Mon p 34

4 **B suberecta** (Collins) Tiffany n comb

B nordstedtii Wittr f *suberecta* Collins Mon p 37 fig 18

5 **B glabra** (Hirn) Tiffany n comb

B sessilis Wittr f *glabra* Hirn Mon p 39 fig 20

6 **B norvegica** (Wittr) Tiffany n comb

B tenuis (Wittr) Hirn var *norvegica* (Wittr) Hirn Mon p 44 fig 60

7 **B litoralis** (Hirn) Tiffany n comb

B rhadinospora Wittr var *litoralis* Hirn Mon p 47 fig 68

8 **B reticulata** Nordstedt

B insignis Pringsh var *reticulata* (Nordst) Hirn Mon p 49 fig 63

9 **B regalis** (Wittr) Tiffany n comb

B imperialis Wittr var *regalis* Wittr Mon p 49 fig 65

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[1] Tiffany L H 1930 *The Oedogoniaceae* a Monograph including all the known species of Bulbochaete Oedocladium and Oedogonium Published by the Author Columbus Ohio

[2] The abbreviation Mon will be used throughout to indicate the above Monograph in which the variety or form is described and figured

OEDOGONIUM Link 1820

1 **Oe vulgare** (Wittr) Tiffany n comb

Oe cryptoporum Wittr var *vulgare* Wittr Mon p 66 fig 102

2 **Oe australe** (G S West) Tiffany n comb

Oe suecicum Wittr var *australe* (G S West) B H Smith[1] 1932 p 193 *Oe suecicum* f *australe* G S West Mon p 68 fig 117

3 **Oe lemmermannii** Tiffany n nom

Oe cardiacum (Hass) Wittr var *minus* Lemm Mon p 71 fig 129

4 **Oe fennicum** Tiffany n comb

Oe intermedium Wittr var *fennicum* Tiffany Mon p 73 fig 135

5 **Oe patulum** Tiffany n nom

Oe hirnii Gutwinski var *africanum* G S West Mon p 73 fig 138

6 **Oe robustum** (West & West) Tiffany n comb

Oe fragile Wittr var *robustum* (W & W) Tiffany Mon p 75 fig 146

7 **Oe subellipsoideum** Tiffany n nom

Oe upsaliense Wittr var *fennicum* Hirn Mon p 78 fig 158

8 **Oe gracilius** (Wittr) Tiffany n comb

Oe plagiostomum Wittr var *gracilius* Wittr Mon p 81 figs 141 and 142

9 **Oe diversum** (Hirn) Tiffany n comb

Oe capilliforme Kuetz Wittr var *diversum* (Hirn) Tiffany Mon p 82 fig 178

10 **Oe maximum** West

Oe fabulosum Hirn var *maximum* (West) Hirn Mon p 83 figs 217 and 218

11 **Oe paraguayense** Tiffany n nom

Oe fabulosum Hirn var *punctatum* Lemm Mon p 84

12 **Oe angustum** (Hirn) Tiffany n comb

Oe grande Kuetz Wittr var *angustum* Hirn Mon p 86 figs 198 and 199

13 **Oe majus** (Hansg) Tiffany n comb

Oe grande Kuetz Wittr var *majus* Hansg Mon p 86 fig 197

14 **Oe amplum** Magnus & Wille

Oe crassum (Hass) Wittr var *amplum* (M & W) Hirn Mon p 88 figs 204 and 205

15 **Oe longum** Transeau n comb

Oe crassum (Hass) Wittr var *longum* Transeau Mon p 88 fig 208

16 **Oe carolinianum** Tiffany n nom

Oe paludosum (Hass) Wittr var *americanum* Nordst Mon p 90 fig 233

17 **Oe. occidentale** (Hirn) Tiffany n comb

Oe boscii (Le Clerc) Wittr var *occidentale* Hirn Mon p 92 figs 227 and 228

18 **Oe. aureum** (Tilden) Tiffany n comb

Oe crenulatocostatum Wittr var *aureum* Tilden Mon p 93 fig 245

[1] Smith B H Proc Indiana Academy of Science 41 177 206

19. **Oe. longiarticulatum** (Hansg.) Tiffany n. comb.
Oe. crenulatocostatum Wittr var *longiarticulatum* Hansg Mon. p 93, figs. 242 and 243

20. **Oe. paucostriatum** Tiffany n nom.
Oe paucocostatum Trans var *gracilis* Tiffany Mon. p. 98, fig 278

21. **Oe. abbreviatum** (Hirn) Tiffany n. comb.
Oe. pringsheimii Cramer, Wittr var *abbreviatum* Hirn Mon p 107, fig. 331.

22. **Oe. commune** (Hirn) Tiffany n. comb.
Oe nodulosum Wittr var *commune* Hirn Mon p 108, fig 376

23. **Oe. epiphyticum** Transeau & Tiffany n nom.
Oe pisanum Wittr. var *gracilis* T & T Mon p 110, figs 365 and 366

24. **Oe. amplius** (W. R. Taylor) Tiffany n. comb.
Oe pyrulum Wittr var *amplius* Taylor Mon p 111, fig 350

25. **Oe. hallasiae** Tiffany n. nom.
Oe oblongum Wittr f *sphaericum* (Hallas) Hirn Mon p 117, figs 368 and 369 *Oe sphaericum* Hallas, preoccupied by *Oe sphaericum* (Hass) Kuetz (De Toni 1889, p 90)

26. **Oe. sinuatum** Transeau n nom.
Oe undulatum (Breb) Al Br, Wittr var *americanum* Transeau Mon. p 119, fig 408

27. **Oe. canadense** Tiffany n. comb
Oe hystrix Wittr var *canadense* Tiffany Mon p 121, fig 418

28. **Oe. subglobosum** (Wittr) Tiffany n comb.
Oe. hystrix Wittr var *subglobosum* Wittr Mon p 121, fig 419

29. **Oe. acutum** (West & West) Tiffany n. comb.
Oe. spirale Hirn var *acutum* West & West Mon p 123, fig 430

30. **Oe. latviense** Tiffany n. comb.
Oe spirale Hirn var *latviense* Tiffany Mon p 123, fig 429

31. **Oe. zehneri** Tiffany n. comb
Oe braunii Kuetz, Pringsh var *zehneri* Tiffany Mon p 125, fig 459

32. **Oe. angulosum** Hallas
Oe. sexangulare Cleve var *angulosum* (Hallas) Hirn Mon p 126, figs. 455 and 456

33. **Oe. subsexangulare** Tiffany n nom
Oe sexangulare Cleve var *majus* Wille Mon p 127, fig 457

34. **Oe. westii** Tiffany & Brown n comb.
Oe borisianum (LeCl) Wittr var *westii* Tiffany & Brown Mon p 128, fig 470

35. **Oe. idioandrosporum** (Nordst & Wittr.) Tiffany n. comb.
Oe crassiusculum Wittr var *idioandrosporum* Nordst & Wittr Mon p 130, figs 475 and 476

36. **Oe. magnum** (Ackley) Tiffany n comb.
Oe multisporum Wood var *magnum* Ackley Mon p 131, fig 452.

37. **Oe. incertum** Tiffany n. nom.

Oe cyathigerum Wittr. f. *americanum* Wolle. Mon p. 134.

38. **Oe. perfectum** (Hirn) Tiffany n. comb.

Oe cyathigerum Wittr. f. *perfectum* Hirn Mon. p. 134, figs. 486 and 487.

39. **Oe. striatum** Tiffany n. nom.

Oe wolleanum Wittr. f. *insigne* (Nordst) Hirn. Mon p. 136, figs. 482 and 483.

40. **Oe. rectangulare** (Rich) Tiffany n. comb.

Oe concatenatum (Hass) Wittr. var *rectangulare* Rich. Mon. p 137, figs. 496 and 497

41. **Oe. exoticum** (Hirn) Tiffany n. comb.

Oe cleveanum Wittr f *exoticum* Hirn Mon p 138.

42. **Oe. subplenum** Tiffany n. nom.

Oe areschougii Wittr. var. *americanum* Tiffany Mon p 140, fig. 501.

43. **Oe. pseudoplenum** Tiffany n nom.

Oe areschougii f. *robustum* Hirn. Mon p 140, figs. 502 and 503.

44. **Oe. exostriatum** Tiffany n nom.

Oe oelandicum Wittr ; Hirn f *minus* Borge Mon p 142, fig 540

45. **Oe. senegalense** (Nordst) Tiffany n. comb.

Oe longicolle Nordst var *senegalense* Nordst Mon p 144, figs 518 and 519

46. **Oe. acuminatum** (Hirn) Tiffany n. comb.

Oe macrandrium Wittr f. *acuminatum* Hirn Mon. p 151, fig 550.

47. **Oe. borgei** (Hirn) Tiffany n. comb.

Oe monile Berk & Harv f *borgei* Hirn Mon p 154, fig 567.

48. **Oe. eminens** (Hirn) Tiffany n. comb.

Oe monile Berk & Harv var *eminens* Hirn Mon p 154, figs 568 and 569.

49. **Oe. exmonile** Tiffany n nom.

Oe monile Berk & Harv f *victoriense* West Mon p 154, fig 566

50. **Oe. completum** (Hirn) Tiffany n. comb.

Oe obtruncatum Wittr var *completum* Hirn Mon p 155, figs 579–582.

Television in Time.

This book is sheer fantasy, reminiscent of Wells, Doyle and Verne at their best. It is scientific fantasy, however, and presents intriguing possibilities of future development in television. In the story, a televisor is devised which when applied to fossils, rocks or other ancient objects, projects about itself a vivid reconstruction of the events which have taken place during the time the object has been exposed to light The analysis of past events, in which the reader becomes a witness of the actual happenings, moves dramatically across the centuries as continents and oceans form and change, hordes of prehistoric monsters march across the panorama of the years, and the struggle for existence goes ceaselessly on The book will provide a fascinating evening's entertainment for anyone with a vestige of imagination. L. H. S

Before the Dawn, by John Taine. vii+247 pp. Baltimore, the Williams and Wilkins Co.

THE ALGAE OF THE URBANA (OHIO) RAISED BOG[1]

FLOYD B. CHAPMAN
Ohio State University

The algae of the Urbana Raised Bog form such an interesting feature of the area, that special effort has been made by the writer to study this aspect of the flora. This unique bog is located at Urbana, Ohio, just north of the Champaign County Fair Grounds. It has been developed around an artesian spring, and due to hydrostatic pressure below and a mat of roots above, has become "raised" or dome-shaped, the center being some ten feet higher than the margins. It is covered with a shrubby type of vegetation consisting chiefly of shrubby cinquefoil (*Dasiphora fruticosa*)

The vascular flora of the bog has been studied by Dr Robert B Gordon (2), of the Botany Department at Ohio State University, and it was upon his suggestion that the present work on the algae was undertaken The first collection of algae was made in early February, 1932, by Gordon, and since that time, much additional material has been obtained, particularly during the spring and summer months of the same year and in 1933. The list of algae from the raised bog is not large, perhaps on account of peculiar environmental conditions which will be discussed in this paper.

The writer wishes to thank Dr. Helen J. Brown and Dr. L. H. Tiffany for aid in identification of certain algae, especially members of the genus *Vaucheria*.

ALGAL HABITATS

Probably the most important algal habitat at the raised bog is a wide drainage ditch which encircles the entire area This ditch, during the spring months is well filled with water and remains so until late July, when it becomes much smaller in size. This ditch is fed throughout the year by several springs which flow from the raised bog, and also by a small stream which issues from drainage tiles to the east. In the spring and early summer months the ditch is choked with water-cress (*Sisymbrium nasturtium-aquaticum*,) *Batrachium circinatum*,

[1]Papers from the Department of Botany, Ohio State University, No. 346

Chara foetida, *Chara fragilis*, and *Zannichelia palustris*. In the early summer months when the water supply decreases, numerous species of herbaceous plants begin to grow along the ditch until the whole is shaded by their dense and rank growth Most important of these are species of *Carex*, *Rumex*, and *Persicaria* The ditch remains in this condition until late autumn, when the plants are killed by frost, and the fall rains come At that time it becomes filled to capacity with water again

Other interesting situations for algae are the several springs which issue from the bog. The waters of these are cold, clear, and are impregnated with lime A constant flow of water issues from these springs throughout the year The temperature of the water is uniformly cool in summer and winter, the temperature being 55° F on a very hot day in late July. The volume of the springs is diminished to some extent during the summer months, and at that time they are surrounded by various herbaceous plants comprising the same species which grow along the ditch The shade produced by this dense growth of vegetation is sufficient to prevent growth of algae except, perhaps, some bluegreens and diatoms

SEASONAL CHANGES IN THE ALGAL FLORA

During February, March, and April, the dominant algae are *Tetraspora lubrica*, *Stigeoclonium stagnatile*, *S. subsecundum*, and *Microspora quadrata* A number of species of *Spirogyra* and one of *Mougeotia* in the vegetative condition are also very common at this season, and persist until May and June when they begin to fruit All of these occur in the ditch which encircles the bog proper In April such forms as *Vaucheria sessilis*, *V woroniniana*, *V geminata*, and *V geminata* var. *longistipata* var. nov appear in the springs Reproductive structures of *Vaucheria ornithocephala* were found on February 13, 1932 All of these forms usually form a dark green mat on the wet, black muck surrounding the springs, and frequently are found submerged in the flowing water, attached to soil *Chara foetida* and *C. fragilis* grow in the alkaline waters of the ditch at all times of the year, and both were found fruiting several times in April and again in September In May, June, and July the dominant forms are the filamentous green algae, comprising the genera *Spirogyra* and *Mougeotia*. Throughout the spring months, *Spirogyra weberi* is exceedingly

common in the ditch. It appears as large yellow-green masses until June, when it turns brownish and begins to produce zygospores. Simultaneously, *Spirogyra varians* var. *scrobiculata* begins to fruit. No zygospore production has been seen in *Mougeotia* collected at this bog, although sterile material is found in abundance, and geniculation frequently occurs, especially in what is perhaps *M. genuflexa*

Although ditches are usually favorable habitats for representatives of the Oedogoniales, only one species, *Oedogonium landsboroughi*, was collected Perhaps it is because of the high alkalinity of the waters which flow from beds of marl The hydrogen-ion concentration of these waters was determined colorimetrically in the field on February 22, 1933 A pH value of 9 was recorded. This fact probably explains the absence of a great many other genera of algae

In late May, June, and early July a number of blue-greens were found, consisting of species of *Lyngbya* and *Oscillatoria*. These forms were dominant until the vegetation had developed sufficiently to shut out most of the light from the water They were then succeeded in August and September by enormous quantities of diatoms, which seem to flourish under the conditions of diffuse light, warmer temperatures, and subsequent decay of vegetation. Great masses of iron bacteria form in the ditch in open, sunny places during the hot summer months, accompanying a rapid decay of *Chara* and other water plants

ANNOTATED LIST OF ALGAE OCCURRING IN THE URBANA RAISED BOG

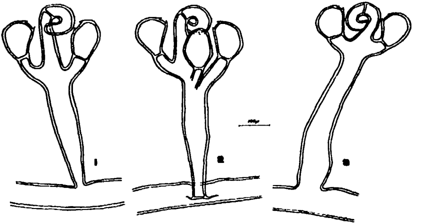
DIATOMACEAE

1. *Nitzschia obtusa* W. Smith. An abundant diatom occurring throughout the year, both in springs and in the ditch
2. *Achnanthes microcephala* Kütz. Abundant.
3. *Synedra ulna* (Nitzsch.) Ehr Abundant in autumn and spring.
4. *Cymatopleura solea* (Breb.) W Smith. Very rare. Spring
5. *Gomphonema intricatum* Kütz Abundant April
6. *Gomphonema montanum* Schum Common. September
7. *Tabellaria fenestrata* (Lyngbh) Kütz. Common. May.
8. *Fragillaria virescens* Ralfs. Common September.
9. *Navicula radiosa* Kütz. Particularly abundant in August and September.

CHLOROPHYCEAE

10. *Closterium moniliferum* (Bory) Ehr. Rare April
11. *Gonatozygon brebissonii* De Bary var. *minutum* W. & G. S. West. Rare. February.

12. *Stigeoclonium stagnatile* (Hazen.) Collins. Abundant in spring months.
13. *Stigeoclonium subsecundum* Kütz. Common in spring months in the ditch.
14. *Stigeoclonium stagnatile* Kütz. April. Rare.
15. *Rhizoclonium hieroglyphicum* (Ag.) Kütz. April. Common.
16. *Tetraspora lubrica* Ag. Common in the ditch. March-April.
17. *Ulothrix tenerrima* Kütz. Rare in the ditch. April.
18. *Geminella minor* Heering. Rare. May.
19. *Microspora stagnorum* Lagerh. Common in spring months.
20. *Microspora quadrata* Hazen Abundant in spring months.
21. *Tribonema minus* (Wolle) Hazen. Rare. April.
22. *Stichococcus bacillaris* Näg. Occasional in April.
23. *Spirogyra weberi* Kütz. Abundant in the ditch. Fruits in June.
24. *Spirogyra varians* (Hass.) Kütz. var. *scrobiculata* Stockmayer. Common in the ditch, fruiting in May and June.
25. *Mougeotia genuflexa* (Dill.) Agardh. Common in the spring months. Often geniculating, but never producing zygospores.
26. *Oedogonium landsboroughi* (Hass.) Wittr. Rare, fruiting in May.
27. *Vaucheria sessilis* D. C. Common, fruiting in April.
28. *Vaucheria geminata* D. C. Common, fruiting in May.
29. *Vaucheria* geminata D. C. var. *racemosa* (Vauch.) Walz. Rare. In the springs.



Figs. 1–3. *Vaucheria geminata* D. C var. *longistipata* var nov. Figs. 1 and 2 show typical specimens. Fig. 3 represents a minor variation, probably an immature individual, but interesting because of the very long stipe.

30. *Vaucheria geminata* D. C. var. *longistipata* var. nov. (Figs. 1–3).
Latin diagnosis: Filamentis 80–106μ latis; ramis fructiferis, erectis, 70–94μ latis, 320–550μ longis; oogoniis 2–5 (plerumque 2–3) continuis, ovoideis vel oblongo-ovoideis, arcuatis, lateraliter sub antheridiis sitis, 70–89μ latis, 99–112μ longis; oosporis eadem

forma ac oogoniis, oogonia complentibus, 65–84μ latis, 93–105μ longis; antheridiis terminalibus, curvatis, 32–38μ latis.

Description: Filaments 80–106μ in diameter; oogonia and antheridia borne at the end of a long branch, 70–94μ in diam., 320–550μ long; antheridium terminal, in typical specimens much surpassing the oogonia, hooked or circinate, 32–38μ in diam.; oogonia 70–89μ wide, 99–112μ long, ovoid or oblong-ovoid, arched, 2–5 in number, usually 2–3; beaks of oogonia short; pedicels of oogonia 32–45μ long, 32–38μ wide, usually arising just below the antheridium, never surpassing it; oospores 65–84μ wide, 93–105μ long, completely filling the oogonia.

This variety has characters intermediate between *V. woroniniana* and *V. geminata*. It resembles the former in the long pedicel and short oogonial beaks, and the latter both in the number of oogonia and the arched appearance of the oogonia. It differs from both in that the antheridia always surpass the oogonia. In the light of these characters it is questionable whether the plant should be made a variety of *V. geminata* or of *V. woroniniana*. Perhaps there is more evidence for the former since *V. geminata* has long been known to vary in various habitats

Type locality: Urbana Raised Bog, Champaign County, Ohio. In flowing springs associated with *Vaucheria ornithocephala* and *V. geminata*.

31. *Vaucheria ornithocephala* Ag. Rare. Found fruiting sparsely on February 13, 1932. This species has not been hitherto reported from Ohio.
32. *Vaucheria woroniniana* Heering. Very rare. Found fruiting on February 13, 1932. This species has not been previously reported from Ohio.
33. *Golenkinia paucispina* W. & G S. West. Common in the ditch in April.

MYXOPHYCEAE

34. *Lyngbya major* Menegh. Rare. April.
35. *Lyngbya aerugineo-caerulea* (Kütz.) Gomont. Common in May and June in the ditch.
36. *Oscillatoria tenuis* Agardh. Common in the ditch during the late spring and early summer months.

CHARACEAE (CHAROPHYTA)

37. *Chara fragilis* Desvaux. Associated with *C. foetida* Fruits from April to October.
38. *Chara foetida* A. Br. Abundant in the ditch. Fruiting from April to October.

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Morbid Inheritance

This book, written by British physicians for physicians and students of human inheritance, attempts to answer three questions frequently asked by those contemplating marriage, or by married couples contemplating parenthood. These questions are "Ought I to get married?" "If I get married, ought I to have children?" "If I get married and have children, what are the chances of their inheriting my disease or a disease which occurs in my family?" It is a sorely needed book, and is very satisfactory as a first attempt. However, it almost completely ignores the important American literature, such as Macklin, Warthin, and Wells on cancer, Kraatz on deaf-mutism, Davenport on goitre, Osborn on baldness, Allan on migraine, etc Each chapter is by a specialist in the field, and the book contains chapters on nervous disorders, mental disorders and deficiency, diseases and abnormalities of the eye, the ear, the blood, the skin, the heart, the kidneys and the skeleton, cancer, tuberculosis, allergies, diabetes, goitre, and gastro-intestinal diseases The discussion of each condition is followed by a "eugenic prognosis" for the condition The treatment is ultra-conservative, which is probably the correct procedure at this stage of our knowledge. The chapter on neoplastic diseases is weak, and not up to the standard of the rest of the volume. The opening chapter by Gates on genetic principles, and the closing one by Hogben on the analysis of pedigrees, are scholarly examples of scientific approach, and add considerably to the value of the book Every physician and every student of human inheritance should read this work —L H SNYDER.

Chances of Morbid Inheritance, by a series of specialists, edited by C P. Blacker xi+449 pp Baltimore, William Wood and Co, 1934.

Man and the Universe

The demand for popular or survey courses in physical science has become so great that many colleges and universities have felt themselves called upon to insert such courses in their curricula An immediate consequence of such action is of course that the book market becomes flooded with textbooks allegedly suitable for such courses This text is just such a one The subject matter, covering a host of subjects embracing physical science from elementary physics to geology and weather forecasts, is treated in a fashion suitable to about seventh or eighth grade pupils in a public school system, but certainly not as suggested by the authors for college students The reviewer can well remember as a junior high school pupil having been made to study just some such book in general science, and while the scholastic level of secondary education may indeed since then have dropped to a new law, he can not be convinced that such a book can have any value whatever in a college survey course in physical science. At the institution where the writer is located a survey course in physical science has been attempted. A year's trial has indicated that it merits repetition, but the plane upon which it has been given has been upon a distinctly higher level than that of the book under review. The book comes well bound in cloth and printed on very good paper and in clear type The book, in the reviewer's opinion, would be suitable for an eighth grade course in general science —H H NIELSEN.

Man and the Nature of His Physical Universe, by F C. Jean, E. C. Harrah and F. L Herman. x+524 pp Boston, Ginn and Co., 1934.

NEW COLEOPTERA (BUPRESTIDAE AND CERAMBYCIDAE)

JOSEPH N KNULL
Ohio State University

Agrilus wenzeli n. sp

Resembling *Agrilus egenus* Gory in size, color and general appearance, color uniformly brownish bronze.

Head greenish bronze, convex, without median depression; surface densely punctured becoming slightly rugose on occiput, densely clothed with recumbent white pubescence, antennae when laid along side of pronotum, extending slightly beyond middle, serrate from the fifth joint.

Pronotum wider than long, wider at apex than at base; sides broadly arcuate, marginal carina strongly sinnate, submarginal slightly sinnate, the two carinae joined near base of pronotum, disk convex, with a shallow median depression extending from base two-thirds toward apex; an oblique lateral depression each side, prehumeral carinae well indicated; surface obliquely rugose, lateral depressions with recumbent pubescence. Scutellum transversely carinate

Elytra constricted near middle, expanded behind middle; sides broadly sinnate, tips obliquely rounded, serrulate, disk slightly flattened, sutural margins elevated in apical third, clothed with short recumbent pubescence which is longer in humeral depressions and along suture, thus giving the appearance of a faint sutural stripe on each elytron

Abdomen beneath sparsely pubescent, pubescence longer on pro-, meso- and meta-sternum, prosternal lobe broadly rounded, first segment of abdomen flattened, somewhat concave posteriorly, first segment covered with short dense pubescence, anterior and middle tibial mucronate on inside at apex; tarsal claws similar on all feet, cleft, the inner tooth broad, shorter than outer one, not turned inward, male genitalia similar to that of *Agrilus falli* Fisher as figured by Fisher [1]

Length, 4.75 mm ; width, 1 25 mm

Female—Differs from the male in having the front of head uniformly reddish cupreous, first two ventral segments of abdomen rounded; the ventral median line of pubescence not as marked; tibiae unarmed.

Type a male labeled Huachuca Mountains, Arizona, July 14 H A. Wenzel collector, in collection of the writer

Paratypes labeled Huachuca Mountains, Arizona, July 10, 14, H. A. Wenzel and Palmerlee, Arizona, in the Wenzel Collection at Ohio State University and collection of the writer

[1]W. S Fisher, U S National Museum, Bull 145, pp 1-347, 1928

I take pleasure in dedicating this species to the late H. W. Wenzel, who presented me with specimens some years ago.

According to Fisher's key, this species would run to *A. chiricahuae* Fisher, but the male genitalia will separate it.

Mastogenius subcyaneous crenulatus n. subsp.

This subspecies resembles *Mastogenius subcyaneous* Lec. in size and shape. It is piceous above and below, with the front less strongly impressed. Pronotum with disk less strongly punctured, crenulate, pubescence arising from punctures longer. Scutellum more elongate. Elytra more densely, coarsely punctured.

Length, 3 mm.; width, 1.2 mm.

Type labeled Clark's Valley. Dauphin Co., Penna., May 24, J. N. Knull, in the collection of the writer.

Paratypes in the U. S. National Museum, the Wenzel Collection at Ohio State University and the collection of the writer as follows: Dunedin, Florida, May 28, W. S. Blatchley; Tybee Island, Georgia, July 8; Southern Pines, North Carolina, May 9, A. H. Manee; Opelousas, Louisiana, Apr. 24; Anglesea, New Jersey; Jeannette, Penna. June 20, H. G. Klages; Manada, Gap. July 11, Mont Alto, July 11, Barbours, May 29, Pennsylvania, J. N. Knull.

Mr. J. P. Darlington, Jr., who kindly compared material with the type series of *Mastogenius* (*Haplostethus*) subcyaneous Lec., informs me that there are four specimens in the type series of the Leconte Collection. He states further, that the first specimen in the series which bears a yellow label indicating a western locality, agrees with this subspecies. The other three specimens in the series from the Southern States have blue elytra and black pronotums.

Since Leconte did not designate a type in his series and all four specimens can be considered cotypes, I designate number two specimen in the series to be known as the type of *M. subcyaneous* Lec.

Aneflomorpha parkeri n. sp.

Slender, testaceous, moderately shining; entire dorsal surface clothed with long cinereous recumbent pubescence.

Head coarsely punctured; eyes moderately large, granulate; antennae with one and one-half joints extending beyond apices of elytra when laid back over dorsal surface, second joint about as broad as long, third joint longer than fourth, fifth joint longer than fourth, joints six to eleven of about equal length, eleventh joint slightly longer than tenth, joints beyond first two flattened, third, fourth and fifth joints with small spines on inside at apices, third, fourth, fifth and sixth joints carinate on upper surface; surface of first four joints coarsely punctured, punctures much smaller on outer joints; long flying hairs numerous on inside of first seven joints.

Pronotum about as wide as long, constricted at base and apex, widest in middle; surface coarsely punctured, a lateral depression on each side in middle, surface somewhat obscured by the dense recumbent pubescence which is intermixed with longer erect hairs. Scutellum more densely pubescent than rest of dorsal surface.

Elytra with sides nearly parallel; suture of each elytron produced into a stout apical spine; surface coarsely punctured at base, punctures less evident toward apices, recumbent pubescence intermixed with longer erect hairs.

Ventral surface covered with long recumbent white pubescence, intermixed with longer hairs; pubescence on legs corresponding to that on ventral surface.

Length, 16.5 mm.; width, 3.5 mm.

Described from a specimen labeled Pinal Mountains, Arizona, Aug. 12, F. H. Parker, Type in writer's collection.

This species can be distinguished from other members in the genus by the prolonged elytral apices.

Aneflus fisheri n. sp.

Resembling *Aneflus sonoranus* Csy. in size, color and form.

Testaceous, clothed above and below with recumbent cinereous pubescence, with round denuded areas, from the centers of which arise longer hairs.

Head coarsely punctured; eyes prominent, coarsely granulate; antennae reaching slightly beyond the middle of elytra in the female when laid back over the dorsal surface, and nearly to the tips in the male, second joint as broad as long, third longer than fourth, fifth joint longer than fourth, joints five to eleven of about equal length, eleventh joint longer than tenth, first three joints globular, remaining joints flattened, joints four to eleven carinate, carinae becoming stronger on outer joints, inner apical angles of third, fourth, fifth, sixth and seventh joints spinose.

Pronotum longer than wide, more constricted at apex than at base; sides broadly arcuate; surface convex, coarsely punctured, the punctures concealed by the vestiture. Scutellum densely pubescent.

Elytra with sides nearly parallel; apices truncate, bispinose; surface coarsely punctured basally, punctures finer toward apices, somewhat concealed by the vestiture, three rows of round denuded areas on each elytron, a large puncture in the center of each bare space, from which arises a long suberect hair.

Length, 26 mm.; width, 5 mm.

Type a male labeled Globe, Arizona, July 10, F. H Parker, in the collection of the writer.

Paratypes in the U. S. National Museum, number 50389, and the collection of the writer as follows:

Tucson, Arizona, July, G. Hofer, Tucson, Arizona, July 13, J. F. Tucker; Sabino Canyon, Arizona July 12, 15, 18, 29, Aug. 6, 10, at light, G. Hofer; Hopkins U. S. 8229, Santa Catalina Mountains, Arizona, Aug. 24, at light, M. Chrisman; Oracle, Arizona, July 23, Hubbard and Schwarz, Allende, Mexico, Oct. A. Busck.

This species comes close to *Aneflus sonoranus* Csy. but can be distinguished from this species by the narrower form, absence of elytral costae and presence of the denuded areas on the elytra.

The writer takes pleasure in dedicating this species to Mr. W. S. Fisher, who kindly loaned material from the National Collection for this paper and compared specimens with types in his charge.

Rhopalophora bicolorella n. sp.

Resembling *Rhopalophora longipes* Say in size; color varying from entirely fuscous to red pronotum, some of the dark forms have slight traces of lighter areas on bases of elytra.

Head and antennae piceous; front with large well separated punctures, finely strigose on occiput; antennae of male considerably longer than elytra, those of female extending slightly beyond tips of elytra, second joint small, as long as wide, third joint longer than fourth, fifth joint longer than fourth, joints six to eleven inclusive gradually decreasing in length

Pronotum dark brunneus, cylindrical, longer than wide, widest in the middle, constricted at base and apex; sides regularly arcuate; disk with a slight indication of a tubercle on each side at base; surface containing irregularly coarsely scattered punctures, a stripe of dense recumbent white pubescence on each side of disk Scutellum triangular.

Elytra fuscous, sides nearly parallel, expanded on apical fifth, hind angles obliquely truncate; disk coarsely punctured throughout, clothed with very short inconspicuous pubescence which is mixed with scattered longer hairs.

Abdomen beneath finely punctured, densely clothed with short pubescence intermixed with longer hairs; prosternum with a round granular opaque area with scattered punctures on each side, area rather variable in some specimens and replaced by rugulae.

Length, 11.5 mm ; width, 1.5 mm

Type a male labeled Palmerlee, Cochise Co., Arizona, July 15, No 50390, in the U. S National Museum.

Paratypes in the U S. National Museum, Wenzel Collection, Ohio State University and the collection of the writer as follows· Fort Grant, Arizona, July 19, Hubbard and Schwarz; Palmerlee, Arizona, July 3, 5, 7, 10 and 14, H. A. Wenzel; Huachuca Mountains, Miller Canyon, Arizona, July 27, H. A Wenzel; Pinal Mountains, Arizona, July 21, F. H. Parker; Burnett Co , Texas, Hubbard and Schwarz; Carizo Springs, Dimmit Co., Texas, Hubbard and Schwarz, San Antonio, Texas, April 18, Hunter and Pratt

This species can be separated from *R. longipes* Say by the cylindrical pronotum and coarse punctures. It lacks the transverse rugulae on *R. rugulosus* Lec.

A GENETIC ANALYSIS OF TASTE DEFICIENCY IN THE AMERICAN NEGRO[1]

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The establishment of the unit character nature of taste deficiency for phenyl-thio-carbamide by Snyder (1931–1932) and Salmon and Blakeslee (1931), following Fox's original discovery that taste deficiency actually existed, is one of the more recent developments in the study of human inheritance The studies of these authors on the inheritance of taste deficiency in man have been confined for the most part to American whites.

Preliminary data collected by the writer on the inheritance of taste deficiency in negroes indicated racial differences in the frequencies of the dominant and recessive genes for taste of phenyl-thio-carbamide The present attempt at a more extensive and critical analysis of the character in the American negro is an outgrowth of the earlier investigation

A human character which occurs with a fair frequency in a given population, should be analyzed beyond a mere inspection of the family histories Although we may evolve a reasonable hypothesis of its hereditary nature from observation, the final proof of the nature of the inheritance must lie in the mathematical analysis of the data on the frequency basis. This mathematical consideration of the frequencies of the allelomorphic genes enables us to predict the proportions of the various kinds of offspring to be expected from the various kinds of matings

The value and reliability of the figures thus obtained will depend on several criteria, among them the number of individuals studied. This point is taken care of in the probable error. Among other criteria that must be considered are mistakes in technique Fortunately the character in question is easily determined. The subject either reports a bitter taste or no taste at all is recorded. As a further precaution, all non-tasters were given a second and third sample of the compound.

[1]Prepared in the genetics laboratory of the Ohio State University, under the direction of Dr. L. H. Snyder.

The crystals were placed on the posterior dorsum of the tongue, in the region of the more sensitive bitter taste buds. The tests include negroes of all ages and both sexes, since recent research has shown that age and sex as well as alkalinity and acidity of the saliva have no effect upon taste deficiency.

A further criterion is the randomness of the sample. The sample in question consists of 3,156 negro individuals, of which 500 were taken from southern schools. The remaining portion is made up of persons taken at random from the negro population of Ohio. The family data and a large number of individuals were collected by the writer and aids in the vicinity of Columbus, Ohio. While a more random sample is possible particularly from the southern states, the present sample serves reasonably well as representing the negro population, since a large number of the northern negro families are recently from the south

As a final criterion, in checking the validity of the figures, a condition of stable equilibrium must be shown. In the absence of selection a new autosomal factor introduced into a population will produce a condition of stable equilibrium after one generation of random mating. In view of the fact that crossing is still taking place to some extent, as well as some selective mating within the hybrid group, the negro population is not altogether the result of random mating and is consequently not at absolute equilibrium. Therefore any deviations of the observed from the calculated proportions (other criteria being accounted for) may be attributed to continued intermixture as well as some selective mating within the hybrid group

In order to obviate the need of distinguishing between homozygous and heterozygous dominants in man we apply the frequency method (Snyder, 1932, 1934)

The values below are derived from 3,156 negroes of which 291 (.092) are non-tasters. This is a significantly smaller proportion than that found in the white race (.298 non-tasters).

Assuming taste deficiency to be a simple recessive character and designating the two allelomorphs as T and t respectively,

Let p = frequency of T
and q = frequency of t.
then $p + q = I$, and $p^2 + 2pq$ = tasters (A)
q^2 = non-tasters (B)
$q \sqrt{B}$.
For this sample $q = .305$ and $p = .695$.

The total sample of 3,156 negroes includes 124 families. This group consists of 509 individuals of which 60 are non-tasters. For the family group, A = .883 and B = .117, and
q = .343
p = .657.

The probable errors for the ratios of the tasters and non-tasters in the family group and the total sample are as follows:

TABLE I

SAMPLE	NON-TASTERS
Total sample	092 ± 003
Family group	117 ± 009
Difference	015 ± 009

The difference in the ratios of tasters and non-tasters in the family group and the total sample is less than three times its probable error. Consequently it is not considered a significant difference, and we may accept the family group as a representative one.

The following chart is a summary of the 124 families studied for the inheritance of taste deficiency for phenyl-thio-carbamide. The sample consists of 509 parents and children.

TABLE II

MATINGS		CHILDREN	
		Tasters	Non-Tasters
Taste × Taste	no.	184	18
	obs	9109 ± 013	0891 ± 013
	calc	9350 ± 006	0650 ± 006
	dev	0241 ± 014	0241 ± 014
Taste × Taste deficient	no.	49	12
	obs	7646 ± 026	2354 ± 026
	calc.	.7451 ± 007	2549 ± 007
	dev.	0195 ± 026	0195 ± 026
Taste deficient × Taste deficient	no.	0	2
	obs.	0 000	1 000
	calc.	0 000	1 000
	dev.	0 000	0 000

From the above table it can be seen that the deviations of the observed proportions from the expected proportions are

less than three times their probable errors. As a final check, the observed values for the proportions of tasting and non-tasting offspring of the various matings were compared with the expected proportions on the basis of the p and q ratio from the total sample The results are shown in Table III.

Here again the observed proportions are near enough the expected proportions to establish the unit character nature of taste deficiency for phenyl-thio-carbamide.

In spite of the fact that intermixture as well as selection within the negro group is taking place, Tables II and III

TABLE III

Matings		Children	
		Tasters	Non-Tasters
Taste	obs	9109 ± 013	0891 ± 013
×	calc	9485 ± 001	0542 ± 001
Taste	dev	0349 ± 013	0349 ± 013
Taste	obs	7646 ± 026	2354 ± 026
×	calc	7673 ± 003	2327 ± 003
Taste deficient	dev	0027 ± 026	0027 ± 026
Taste deficient	obs	0 000	1 000
×	calc	0 000	1 000
Taste deficient	dev	0 000	0 000

indicate that an equilibrium in regard to the taste genes has been fairly well established. Since the frequencies in the original negroes and whites undoubtedly differ greatly, a rather high degree of random mating is necessary to approach the equilibrium that the sample in question indicates. Unfortunately repeated attempts to obtain taste results from West Africa in the region of the forest negroes were of no avail. The only results obtained from Africa were one set from East Africa, and one group from the Egyptian Sudan.

Table IV is a summary of the gene frequency ratios for taste deficiency in the races thus far studied.

In this table the Kenya negroes are not to be looked upon as a true representation of the original negroes brought to America. This group is from East Africa and shows traces of admixture with non-negroid stocks (Hooton, 1931).

The forest negroes, particularly those from the Guinea coast of West Africa, in a large measure made up the parent negro population of America No results were returned from samples of the compounds sent to this group.

The mixed Indian sample does show the effect of crossing with the whites. The non-tasters increase from 060 in full blooded Indians to 106 in mixed Indians. The American

TABLE IV

COLLECTORS	SAMPLE	NO	TASTERS	NON-TASTERS	P	Q
Snyder (1932)	American whites	3643	702	298 ± 005	455	545
Levine and Anderson (1932)	Pure American Indians	183	940	060 ± 011	765	244
Levine and Anderson (1932)	Mixed American Indians	110	896	106 ± 019	674	336
Lee	American negroes	3156	907	092 ± 003	697	305
Lee	Kenya Negroes	110	919	081 ± 017	716	284
Lee	Egyptian Sudan Natives	805	958	042 ± 001	795	205

negro group presents an increase in the proportion of non-tasters of .011 over the Kenya group, and 050 over the Egyptian Sudan natives, and falls between the American whites on the one hand and the Kenya and Egyptian groups on the other hand. The pure blooded Indians show the lowest proportion of non-tasters. However, the mixed group presents a higher proportion of non-tasters than the American negro sample. This higher percentage might easily be accounted for on the basis of social selection The action of the social forces of the American people allow for crossing of American Indians and whites more readily than that of negroes and whites. There is, however, considerable doubt that the three smaller samples are truly representative of their respective groups

This uneven distribution of non-tasters among whites, negroes, and Indians leads to the assumption that a recessive mutation for taste deficiency arose in that group which today presents the highest percent of non-tasters, i. e., the Caucasians. The non-tasters among the negroes and Indians being distinctly low might lead one to believe that they were all originally homozygous tasters, and the recessive factor came about through infiltration with the Caucasians. While such an explanation seems plausible further genetic analysis of human populations is necessary before any conclusions can be drawn.

The analysis of threshold values and the effects of temperature on the various taste reactions are in progress in the laboratory, for the negro groups as well as for the white groups. These results will be published later.

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Science and Sanity

Count Korzybski presents in this monumental treatise a point of view, which, if adopted generally, would revolutionize and rationalize our modes of thought. He discusses and illustrates from an enormous variety of situations the desirability and the present (1934) necessity of the employment of a non-Aristotelian, non-elementalistic sematics, in which the concept of non-identity is fundamental. It is only through such a system of psycho-logic reactions that sound scientific thinking may occur and that one may progress from unsanity to sanity.

Count Korzybski shows how many prevalent fallacies and confusions are based upon misconceptions of the nature of language, particularly upon verbalisms dealing with fallacious identification. He deals exhaustively with the nature of verbal, mathematical and scientific symbolisms, and the conditions which give them their representative value. For sane thinking, these symbols should conform as closely as possible to the realities of the nature of the universe and life. To secure such conformity and establish it by training is a very urgent problem of our times. Implications of the outcomes of such training in the solution of scientific, social, and political problems are far-reaching and important

The author has brought together within the compass of this volume an astounding wealth of material. His discussion of the problem from the physiological, neurological and mathematical points of view has been proclaimed as masterly by many specialists in these fields. The text is difficult; its ideas are new. The reader will find himself struggling with them, but realizing their importance, should adopt them for his own.—JOHN W. PRICE

Science and Sanity, by Alfred Korzybski. A Publication of the International Non-Aristotelian Library Publishing Co. The Science Press, Distributors, Lancaster, Penn. 1933.

How genes act.

In spite of the wide acceptance of modern genetic theories, the embryologist finds himself frequently doubting the role of the genes in embryonic development This book, written as an attempt to reconcile the theory of the gene with the deep-seated and fundamental characters of developing organisms, is by one who is himself both a geneticist and an embryologist, and thus peculiarly fitted for such a task Morgan accepts as complete neither the hypothesis that all the genes are acting all the time in the same way, nor the hypothesis that different batteries of genes come into action as development proceeds In their place he suggests a third hypothesis, that initial differences in protoplasmic regions affect the activity of the genes, which in turn affect the protoplasm, thus creating a series of reciprocal reactions This hypothesis is elaborated as the book unfolds, through cleavage, gastrulation, development of isolated blastomeres, and other experimental anomalies, parthenogenesis, regeneration, and the determination of sex The book does not leave the reader feeling that any of the problems are definitely settled, or even partially solved, but it does raise many pertinent questions, and it does provide genuine stimulation to further thought and research L H S

Embryology and Genetics, by T H Morgan vii+258 pp New York, Columbia University Press, 1934 $3 00

Development and its experimental analysis.

From the vast fund of literature on experimental embryology, the authors of this volume have selected the pertinent contributions to early development and differentiation, and by means of careful synthesis and critical evaluation have woven them into a connected whole Crucial experiments have now been performed on many phases of the developmental process and a book such as this with authoritative interpretations is indeed welcome A particularly illuminating chapter is devoted to the much-discussed question of the genetic basis of embryology The book is well illustrated, and the bibliography is arranged in a unique and useful form, giving subject-matter and page of citation in the volume for each reference Descriptive embryology is rapidly giving way to physiological embryology, and thanks to volumes such as this, he who runs may read L H S

Elements of Experimental Embryology, by J S Huxley and G R DeBeer xiii+514 pp Cambridge, at the University Press, New York, the Macmillan Co 1934

Accurate Measurements

The author, a son of Professor A N Whitehead has had an extensive experience in the design construction and use of precision apparatus, particularly during his years as an expert for the British navy The result is a book which in the opinion of the reviewer should be familiar to every graduate student who hopes to do precision work and which will prove equally valuable to scientists of more extensive experience with instruments

The sections dealing with the theory of errors presents, rather than the idealized mathematical theory restated a new kind of treatment of the problem based on design in relation to use In it the author points out particularly some much neglected facts about the securing of accurate judgments and pointer readings by the observer or manipulator of the instruments Part II deals with Design, again in a stimulating new way The book is not addressed to the designing technician, but will be chiefly valuable to all classes of researchers who use instruments of precision —S RENSHAW

The Design and Use of Instruments and Accurate Mechanisms, by T N Whitehead xii+283 pp New York, the Macmillan Co 1934

Biological Principles as Illustrated by the Protozoa

This second edition of a standard work by the dean of American protozoologists gives evidence of considerable reorganization and new material, although the general purpose and plan of the book remain the same It is today without question the student s best and most reliable source of information on the broader and more fundamental aspects of the life of the Protozoa The concept of a changing organization influenced by continued metabolism is still the central theme of the book

To this edition a valuable chapter on ecology and parasitism has been added The author s decision to omit the Phytomastigophora entirely, leaving them to the botanist, will be regretted by many, although it must be admitted, however reluctantly, that this solution of the problem of duplication will probably be generally adopted in time Typography paper, and binding of the new book conform to the highest standards —W J KOSTIR

The Biology of the Protozoa, by Gary N Calkins 2nd edition, 607 pp Philadelphia Lea and Febiger 1933

Glacial Geology.

This photo lithoprint of the author s manuscript is divided into four main parts and is, as the title shows, in a modified outline form Part I deals with Mountain glaciers and glaciation Part II handles Continental glaciers and glaciation Part III considers the Pleistocene glacial succession Part IV is entitled Miscellaneous and covers the Driftless area, Causes of Pleistocene glaciation, duration of the Quaternary, life of the Pleistocene, and the Economic geology of the Drift There are 10 plates containing 89 figures, these are well selected and are a very definite addition to the outline As in any treatment of glacial geology there are points open to argument but this does not deduct from the value of the work Needless to say it gives the author s **inferences** which he endeavors to keep separate from **observations,** a very excellent idea It is perhaps unfortunate that this outline had to be reproduced by photo lithoprint as most of us find typing more difficult to read than printing This may prove however a good point as it will probably cause the author to revise and enlarge the outline more often than would be the case if it was set up in type In as far as I know it has a field to itself and should prove very useful to students both in and out of glaciated areas WILLARD BERRY

Outline of Glacial Geology by F T Thwaites 115 pp, paper bound Ann Arbor Edwards Brothers 1934

Within the Atom

A truly delightful book written by H A Wilson has appeared under the above title It is a strictly up to date discussion of the progress made since the beginning of the century to solve the riddle of the atom, suitable to be given to the layman or the beginning student It is delightfully and fascinatingly written, the language of mathematics having been replaced by the language of everyday speech, and while many times reading much like a story or a fairy tale, only very little of the actual meaning of the physics involved is sacrificed It is an account of the complete collapse of the old concepts of nineteenth century physics and the rise and triumph of the quantum theory, told by a man who himself has played a part in the revolution and who has a clear vision of the direction in which modern physics will head in the future The book comes durably bound in cloth, printed on good paper in large, clear type, and is sincerely recommended to the reader desiring a glimpse of the physical world as visualized by contemporary physicists For use in introductory or survey courses so much in demand in colleges and universities at the present time, the reviewer feels it is one of the most suitable that has come to his attention —H H NIELSEN

The Mysteries Within the Atom, by H A Wilson x+146 pp New York, D Van Nostrand Co, 1934 $2 50

THE OHIO JOURNAL OF SCIENCE

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DATA ON THE THICKNESS AND CHARACTER OF CERTAIN SEDIMENTARY SERIES IN OHIO

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INTRODUCTION

The total thickness of the sedimentary rocks in Ohio as measured on the outcrop is a little more than 5,000 feet. As the various series pass under cover away from the outcrop changes in thickness occur which can be determined by a study of data derived from well borings. Based on rather limited data of this type, various estimates have been made from time to time of the thickening of certain sedimentary series to the eastward in Ohio along designated lines.[2] However, as deep well drilling has continued the quantity of available data has increased and a comparative study of some 8,500 well records now on file in the office of the Geological Survey of Ohio has yielded the results set forth in the following pages Such data lack much that is to be desired in the way of scientific accuracy and detail, but nevertheless the close correspondence in essential fact of data derived from many sources argues for considerable accuracy in its major features It is believed that the results of such a study will be of interest to geologists and to all who are engaged in the search for oil and gas

CLASSIFICATION OF THE SEDIMENTARY ROCKS OF OHIO

The following table gives a brief classification of the sedimentary strata in Ohio and includes the name and character

[1]Published by permission of Mr Wilber Stout, Director, Geological Survey of Ohio

[2]Hills, T M Some Estimates of the Thickness of the Sedimentary Rocks of Ohio. *Jour Geol*, Vol XXVIII (1920), pp. 84-86 Also various reports of the Geological Survey of Ohio

of the chief subdivisions, the thickness on the outcrop, and the terms in general use by the well driller. Many of the details of the classification have been omitted. The thickness of the different groups, series, formations, or members appearing in this table have been compiled from various detailed reports. The correlations with surface outcrops of the various strata recognized in drilling are in part the conclusions of the writer, and in part the opinions of others which have appeared in various publications of the Geological Survey of Ohio.

TABLE OF CLASSIFICATION

System	Group, Series, or Formation	General Character	Thickness on Outcrop (Feet)	Drillers Terms
Permian	Greene	Many kinds	405	
	Washington	Many kinds	221	
	Monongahela	Many kinds	144	
		Sandstone, Sewickley	20	Goose Run sand
		Several kinds	84	
Pennsylvanian	Allegheny	Many kinds	82	
		Sandstone, Connellsville	20	Mitchell sand
		Several kinds	7	
		Sandstone, Morgantown	0–30	Wolf Creek or Milner sand
		Many kinds	100	
		Sandstone, Cow Run	30	Macksburg 140-foot or First Cow Run sand
		Many kinds	40	
		Sandstone, Buffalo	23	Buell Run sand
		Many kinds	106	
		Sandstone, Upper Freeport	33	Macksburg 300-foot or Dunkard sand
		Many kinds	117	
		Sandstone, Clarion	10	Macksburg 500-foot sand
		Many kinds	34	
	Pottsville	Many kinds	154	
		Sandstone, Massillon	24	Second Cow Run or Salt sand
		Many kinds	93	
		Sandstone, Sharon	10	Macksburg 800-foot, Maxton, or Lower Salt sand

TABLE OF CLASSIFICATION—(*Continued*)

System	Group Series, or Formation	General Character	Thickness on Outcrop (Feet)	Drillers Terms
Mississippian	Maxville	Limestone	0 to 20	Big Lime of southeastern Ohio
	Logan	Sandstone and shale	0 to 200	Keener sand
	Cuyahoga	Sandstone, Black Hand	175 to 600	Big Injun and Squaw sand
		Shale		
		Sandstone, Buena Vista		Hamden, Welsh Stray, or Weir sand
		Shale		
	Sunbury	Shale, black	5 to 30	Coffee shale
	Berea	Sandstone	0 to 200	Berea sand
	Bedford	Shale, gray and red	60 to 90	
		Sandstone, local		Second Berea sand
Devonian	Ohio	Shale, black, Cleveland	300 to 700	Little Cinnamon and Big Cinnamon
		Shale, gray, Chagrin		
		Shale, black, Huron		
		Shale, gray, Olentangy		
	Delaware	Limestone	30 to 70	
	Columbus	Limestone	60 to 110	
	Detroit River	Dolomite	0 to 200	
	Sylvania	Sandstone	0 to 20	Big Lime (The Oriskany sand, salt beds and Newburg sand occur in this series)
Silurian	Bass Island	Dolomite and shale	0 to 300	
	Niagara	Dolomite	25 to 300	
	Alger	Shale	10 to 100	
	Dayton	Limestone	2 to 12	Shell or Little Lime
	Brassfield	Limestone	10 to 50	Shell or Little Lime
Ordovician		Shale, red and gray		
		Sandstone, red and white		Clinton sand
		Shale, red		Medina
	Richmond	Shale, pink and red	215 to 265	
		Shale, bluish gray, with thin limestone		
	Maysville	Shale and thin limestone	140 to 240	
	Eden	Shale, blue, with thin limestone	180 to 250	
	Trenton*	Limestone	40 to 200	
	Lexington	Limestone, cherty	290 to 315	Trenton
	Highbridge	Limestone and dolomite with some shale	250 to 420	
	St Peter	Sandstone, calcareous		St Peter sand, Horizon of Blue Lick Water

*The series below the Trenton do not outcrop in Ohio.

THE SEDIMENTARY SERIES BELOW THE ST. PETER SAND

A number of holes have been drilled in the western half of Ohio to varying depths below the St Peter sand, but only a few have actually reached the underlying crystalline complex. In a test hole which was sunk near Findlay, Hancock County, in 1912 and which reached the granite at a depth of 2,980 feet, 780 feet of sediments were penetrated below the St. Peter sand A second test near Woodville, Sandusky County, encountered 730 feet of sediments below the St. Peter sand and reached a depth of 2,822 feet. The drill has also reached the crystallines near Tiffin, Seneca County, at a depth of about 2,900 feet, but the details of this record are not available. A number of years ago a deep test was drilled near Waverly, Pike County, in which the St. Peter sand was reached at 2,825 feet and fragments of igneous rock were reported to have been secured at a depth of 3,320 feet.[3]

The deepest test in the western half of Ohio was drilled near South Charleston, Clark County, in 1926–1927. The drill reached a depth of 4,647.5 feet, but it failed to pass through the sedimentaries. The Blue Lick water sand or St. Peter was encountered at a depth of 2,055 feet, and it is therefore underlain at this place by at least 2,592 feet of sediments or over three times the thickness occurring below the St Peter at Findlay or Woodville

It is highly probable that the upper surface of the crystalline rocks upon which the sediments were deposited was very irregular and in view of the small number of holes which have been drilled through the entire series in Ohio, any prediction as to its depth outside of the Findlay-Woodville-Tiffin area is somewhat hazardous.

THE TRENTON-ST PETER SERIES

The series from the top of the Trenton to the St. Peter sand is composed of limestone and dolomite with some shale in the lower part which is usually of a greenish color. The upper part of this series is exposed along the banks of the Ohio River at Cincinnati, but the lower part consisting of the Lexington and Highbridge series does not outcrop in this state, although it comes to the surface farther south in Kentucky.

[3]Bassler, R. S The Stratigraphy of a Deep Well at Waverly, Ohio. *Am. Jour. Science*, 3rd. Ser., Vol. 31 (1911), pp. 19-24.

Below this limestone, dolomite, and shale series is a bed of white calcareous sand or sandy limestone which contains large quantities of strong brine known as the Blue Lick water. This water-bearing sand is the St. Peter sand of Orton[4] and it is generally known among well drillers by that name The St. Peter sand does not outcrop in Ohio or Kentucky, but it has been reached at a number of places by the drill At least 80 holes have been sunk to this horizon in Ohio, nearly all of which are located in the western two-thirds of the state and chiefly east of the belt of Trenton production

By a comparison of well records it has been found that the St. Peter sand occurs at distances below the top of the Trenton, which vary from 435 to 885 feet. The series is thin over an elongated area extending from Columbus southwest to western Pike and eastern Highland counties and also along the western edge of the state in western Butler, Preble, and Darke counties A second area of reduced thickness extends from Allen County northeast to Erie County This latter area seems to be continuous with a similar region of thinning extending in a northeastern direction across southwestern Ontario[5] The series thickens, however, to the northwest in the direction of Michigan and to the southeast in eastern Ohio The conditions of thickening and thinning of the Trenton-St Peter series as indicated by well records are shown in Figure 1.

THE TRENTON-BIG LIME SERIES

The Trenton-Big Lime series outcrops in southwestern Ohio where it forms the surface rocks in Hamilton, Butler, Warren, Clermont, and Brown counties and in portions of adjacent counties to the east and north Beyond this outcrop area the series extends beneath younger beds throughout eastern and northern Ohio. It has been penetrated by the drill at many places in the western half of the state, but it is probably best known to the driller in the producing fields in the northwestern part where hundreds of wells have been sunk to the Trenton limestone. The thickness of the Trenton-Big Lime series as disclosed by well records varies from 660 to 1,950 feet. The thinnest areas are found in Williams and Defiance counties, from where this series thickens irregularly to the east and

[4]Orton, Edward. *Geol. Survey, Ohio*, Vol. VI (1888), p. 7.
[5]See map of southwestern Ontario by R. B. Harkness, Ontario Gas Commissioner.

southeast, while the greatest thickness is encountered along the eastern line of Trenton holes Thus, this series measures

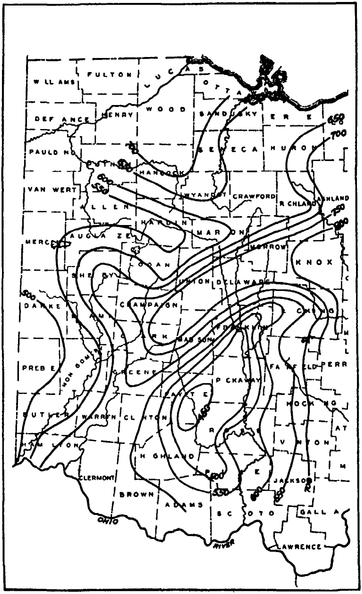

FIG 1 Map of the western part of Ohio showing isopachs of the series extending from the St Peter (Blue Lick water) horizon to the top of the Trenton limestone

1,950 feet in Rome Township, Ashtabula County, 1,700 feet in Brunswick Township, Medina County, 1,360 feet in Jackson Township, Ashland County, 1,560 feet in Hanover Township, Licking County, and 1,400 feet in Jefferson Township, Jackson County Southeast of this line the drill has not penetrated to a level much below the horizon of the Clinton sand

The Trenton-Big Lime series consists of shales and thin limestones comprising the Eden Maysville, Richmond, Brassfield, Dayton, and Alger beds Throughout all parts of Ohio where this series has been penetrated, a limestone which varies in thickness from 5 to 75 feet and which is known to the driller as the Shell or Little Lime, is present near the top of the series and corresponds in position to the Brassfield and Dayton limestones of surface outcrops In parts of the belt of Clinton sand production two "shells" are present, separated by a thin bed of shale The Shell or Little Lime is separated from the base of the Big Lime by a bed of shale which as pointed out by Orton,[6] is 15 feet or less in thickness in the west-central part of Ohio This shale increases somewhat in thickness to the east and southeast, however, for in the belt of Clinton sand production it ranges from 75 feet in Lorain County to 250 feet in Lawrence and southern Jackson counties The material is generally of a greenish gray color, but red shales are common on this horizon in southern Ohio The Shell is more or less closely underlain with red shale and the red and white Clinton sand

A second conspicuous feature of the series is a bed of black and brown shale which overlies the Trenton and which often yields small flows of gas This shale which forms the lower part of the Eden group is known as the Utica shale[7] It is thin in southwestern Ohio, but it increases in thickness rapidly to the north, northwest, and northeast The Utica shale has a thickness of about 35 feet in southern Butler County 200 feet at Dayton in Montgomery County, 300 feet at Urbana in Champaign County, and apparently reaches its maximum thickness of 350 feet in Logan and Hardin counties It thins slightly to the north, east, and west from Logan and Hardin counties, for it measures 290 feet at Van Wert, 300 feet at Napoleon, 275 feet at Bowling Green, 225 feet in southwestern

[6]Orton Edward *Geol Survey, Ohio* Vol VI (1888) p 13
[7]Orton, Edward *Geol Survey, Ohio* Vol VI (1888), p 8

Ottawa County, and 285 feet near Tiffin. The Utica shale thickens again in the vicinity of Sandusky, where it measures

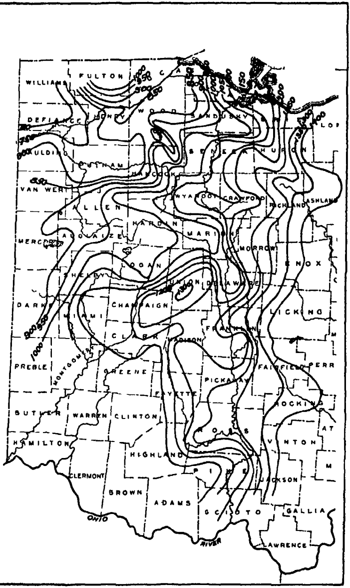

FIG. 2. Map of the western part of Ohio showing isopachs of the series extending from the Trenton Limestone to the base of the Big Lime.

about 335 feet. The thickness of the Trenton-Big Lime series in the western half of Ohio is shown in Fig. 2.

THE BIG LIME SERIES

The Big Lime series is well known to the driller, as a part or all of this group is penetrated in wells sunk to the Trenton or Clinton sands. This series forms the surface rocks in the Trenton field of northwestern Ohio and the surface exposures extend eastward to a line drawn from Sandusky Bay south through Delaware, Columbus, Greenfield, and Bainbridge and then southward to the Ohio River through eastern Adams County. East of this line the Big Lime dips beneath beds of younger age.

The thinnest part of the Big Lime as recorded in well records is found in Scioto and Pike counties where it measures about 300 feet. It thickens rapidly to the east and northeast, however, for it reaches its maximum development in Ohio along the eastern edge of the state from Columbiana County south to Washington County. From central Columbiana County this series thins again to the north in the direction of Conneaut. The greatest thicknesses yet recorded in this state are 1,987 feet in the Reamer well located in West Township, Columbiana County, and 1,841 feet in the Knowlton well in Independence Township, Washington County.

Stratigraphically the Big Lime includes the limestone and dolomite from the base of the thick Devonian shale to the base of the Niagara dolomite and comprises the Delaware and Columbus limestones, the Detroit River and Bass Island dolomites, and the Niagara dolomites as classified from surface exposures. The increase in thickness of the Big Lime series to the east in Ohio is due in part to the increase in thickness of some of the formations comprising it, and in part to the presence of other formations under cover which pinch out to the west before the outcrops are reached. Thus the Devonian limestones consisting of the Columbus and Delaware formations have a combined thickness on the outcrop of about 130 feet. Under cover the Oriskany sand which lies at the base of the Devonian limestone is found at depths below the top of the Big Lime of 110 to 160 feet in Guernsey County, 200 to 290 feet in Ashtabula County, 235 feet in Island Creek Township, Jefferson County, and 225 feet in Independence Township, Washington County.

In northeastern Ohio beds of rock salt with some shale and

dolomite, all of which probably represent the Salina group, are present in the Big Lime below the Oriskany sand horizon.

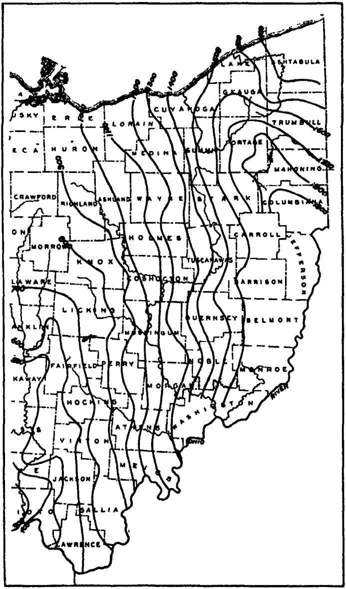

FIG. 3. Map of the eastern part of Ohio showing isopachs of the Big Lime series.

These beds in Ashtabula County approach 600 feet in thickness. This series thins to the west and southwest, however, the salt pinches out, and the dolomite and gypsum are not represented in the outcrops in west-central Ohio and their correlation with exposures in northern Ohio is uncertain.

Dolomite extends from the Salina to the base of the Big Lime. The widespread occurrence of a strong flow of brine about 150 to 300 feet above the base of the Big Lime suggests a persistent horizon of high porosity such as the upper surface of the Niagara dolomite. If this flow of brine comes from a definite stratigraphic horizon, there is little evidence for believing that the part of the Big Lime below it thickens much to the east in Ohio. As indicated from the foregoing discussion, the thickening of the Big Lime to the east is believed to occur chiefly in its middle portion. Greater detail within the Big Lime is impossible without a careful and extended study of drill cuttings. The thickness of the Big Lime series in different parts of the eastern half of Ohio is shown in Fig. 3.

THE BIG LIME-BEREA SERIES

The interval from the Big Lime to the Berea sand consists for the most part of black, brown, bluish gray, and red shales comprising the Ohio shale and Bedford shale formations. These shales outcrop over a belt of territory varying from two to twenty miles in width, extending from eastern Adams County northward to Erie County and then eastward along the shore of Lake Erie to the Pennsylvania line. The shales have a thickness on the outcrop in Adams County of about 340 feet, but they thicken irregularly to the north along the outcrop, reaching a depth of about 550 feet in Erie County. Eastward from Erie County the expansion is marked for near Cortland, Trumbull County, the thickness is about 2,300 feet.

Under cover the Big Lime-Berea series also shows a great expansion in thickness to the east. Along an east-west line from Pike Township, Knox County, to New Cumberland, Hancock County, West Virginia, the rate of expansion is about 28.9 feet per mile, while along a similar east-west line from Newark, Ohio, to Wheeling, West Virginia, this shale series increases in thickness to the east at the rate of about 33 feet per mile. From western Guernsey County to Wheeling the rate of increase is about 40 feet per mile. The expansion along a third east-west line from western Hocking County to eastern

Washington County is about 34 feet per mile to the east. The two greatest thicknesses yet encountered in tests drilled in

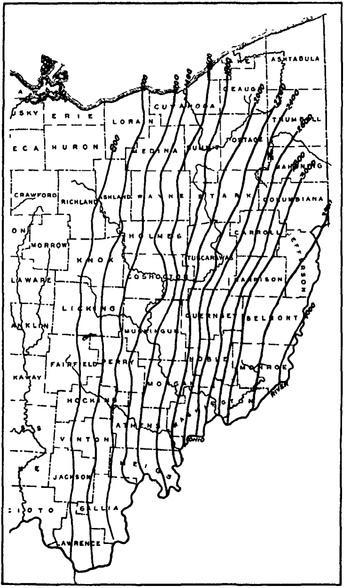

FIG. 4. Map of the eastern part of Ohio showing isopachs of the series extending from the top of the Big Lime to the base of the Berea Sand.

Ohio are 3,427 feet in Section 26, Island Creek Township, Jefferson County, and 3,341 feet in Section 10. Independence Township, Washington County.

The Ohio shale in northern Ohio is generally subdivided into three parts: a basal black shale or Huron, a middle gray shale or Chagrin, and an upper black shale or Cleveland member. This three-fold subdivision is not generally applied to the outcrops in central and southern Ohio although bluish-gray shale somewhat similar lithologically to the Chagrin is present in the middle portion in both regions and gives a three-phase character to the formation. Beneath the lower black shale of the Ohio formation and extending to the top of the Big Lime, there is another bed of blue shale which is persistent on the outcrop in central Ohio and which is found at many places in southern Ohio. This is the Olentangy formation of various reports on the geology of Ohio, but it is considered by the writer to be a phase of the Ohio formation.[8]

East of the belt of outcrops, black, brown and blue shales are encountered by the drill in all wells which have penetrated far below the Berea sand West of a line from central Stark to central Lawrence counties the Big Lime is immediately overlain by material which is variously described as white or gray shale This light material has a thickness of about 300 feet in western Stark County, 175 feet in western Muskingum County, and about 110 feet in western Lawrence County It thins to the west and northwest of this line and at places it can be traced close to the outcrop. The stratigraphic position of this light shale suggests that it represents the eastern continuation of the so-called Olentangy shale of surface outcrops This bed increases in thickness east of the line from central Stark to central Lawrence counties, but it is separated from the Big Lime by a wedge of black or brown shale which thickens to the east. In the deep well drilled on the Jones farm in Warren Township, Belmont County, the Big Lime is immediately overlain by 200 feet of black shale representing this wedge, above which occurs the gray shale; while in the test drilled in Island Creek Township, Jefferson County, the Big Lime is overlain by 400 feet of black shale with 775 feet of light shale above it.

Overlying the light shale which in the western part of the

[8]Lamborn, R. E The Olentangy Shale of Southern Ohio. *Jour Geol.*, Vol. XXXV (1927), pp 708–722

field forms the base of the Ohio shale there is a bed of black or brown shale which is generally known to the driller as the Cinnamon. Over large areas in eastern Ohio the Cinnamon is divided into two parts by a thin bed of blue or gray shale. The upper and thinner portion is called the Little Cinnamon, while the lower and thicker portion is known among the drillers as the Big Cinnamon. Showings of gas are of widespread occurrence in both of the cinnamon shales and the commercial production of shale gas in Lawrence County is apparently derived from these beds. The thickness of the Cinnamon shale along the first line of Clinton production from Jackson County to Lorain County varies irregularly from 300 to 400 feet. It increases in thickness somewhat to the southeast, however, for in general it measures 450 to 550 feet along a zone from western Noble County to western Columbiana County. The black Ohio shale of outcrops in central and southern Ohio is believed to represent the western continuation of the Cinnamon shale of the driller.

The shale from the Cinnamon to the base of the Berea sand is the most variable element in the Big Lime-Berea series, as it expands rapidly to the east in Ohio and as it is composed of a wide variety of materials. Along a north-south line from central Vinton County to central Ashland County this shale varies from 350 to 450 feet in thickness. It expands rapidly to the east, however, for it attains a thickness of 780 feet in northeastern Gallia County, 800 feet or more in central Athens County, 1,150 feet in central Guernsey County, and 1,400 feet or more in eastern Tuscarawas, western Carroll, and western Columbiana counties. In the deep test drilled in Island Creek Township, Jefferson County, in 1931 the shale between the Cinnamon and the Berea sand was found to have a thickness of 1,667 feet.

Red shale and thin sandstone are conspicuous elements in the shale series between the Cinnamon and the Berea. The red shale which for the most part is found less than 75 feet below the Berea sand is correlative with the red shale of the Bedford formation of surface outcrops. Sandstone is present close below the red shale and 20 to 60 feet below the Berea sand at some localities in western Medina and eastern Lorain counties. The position of this sandstone suggests that it represents the Euclid member of the Bedford formation. Sandstone occupying a similar position with respect to the

Berea is likewise found at many localities in southern Ohio. Through eastern Gallia, Meigs, Athens, eastern Morgan, and southern Muskingum counties a productive sandstone known as the Second Berea sand is present 15 to 75 feet below the Berea, from which it is separated at many places by red shale. This sandstone is likewise believed to be Bedford in age. Little detail can be derived from the series extending from the position of the Second Berea sand to the Cinnamon shale. Gray shale predominates in this interval, although red and pink shales are reported in the northeastern part of the state. The great array of productive sands below the Berea in West Virginia and western Pennsylvania belong in this series, but they either pinch out to the west or become so thin in eastern Ohio that they are generally described by the driller as "shells" and can not be correlated with accuracy. A notable exception, however, occurs in the presence of a thin sand of rather wide distribution which is found some 300 to 400 feet below the Berea sand.

THE MISSISSIPPIAN SERIES ABOVE THE BEREA SANDSTONE

The Mississippian series above the Berea sandstone outcrops over a broad belt extending from Scioto and eastern Adams counties on the south to Medina, Lorain, and southeastern Erie counties on the north and then eastward over a somewhat narrower belt embracing portions of Summit, Cuyahoga, Geauga, Trumbull, and southern Ashtabula counties. From the region of outcrop the series slopes to the southeast beneath the Pennsylvanian and Permian strata which constitute the surface beds in the southeastern third of the state. The most conspicuous formation above the Berea sand which can be followed under cover by well records is the Maxville limestone, the youngest formation of the Mississippian system in Ohio. The Maxville limestone apparently remains as an unbroken sheet over Monroe, southern Belmont, and eastern Noble counties where it varies from 25 to 200 feet in thickness. North, west and southwest of this area the limestone is patchy in distribution, for at many places it has been entirely removed by erosion occurring at the end of the Mississippian period and preceding the deposition of the Pennsylvanian sediments. Enough limestone remnants remain, however, to mark the contact of the systems over large areas and to permit the

determination of the thickness of the Mississippian strata above the Berea with some degree of accuracy.

Where the Maxville limestone has been removed other criteria for determining the position of the contact must be applied. White sands are relatively rare in the outcrops of Mississippian rocks but are of common occurrence in the lower part of the Pennsylvanian. White sands, therefore, found close above the Berea sand and accompanied by reduced intervals from the Berea to known horizons in the Pennsylvanian are considered as representing the basal portion of the Pennsylvanian

The thickness of the Mississippian strata above the Berea is apparently greatest along the western outcrop from southern Hocking County northward to Ashland and Wayne counties. In Hocking County the thickness of this series varies from 750 to 850 feet; in southern Licking and southeastern Ashland counties it is about 700 feet; and in Wayne County the maximum thickness measures 870 feet[9] From east-central Ohio the series thins somewhat to the southeast, but the most notable reduction in thickness is from the south and west toward eastern Stark, northern Columbiana, and southern Mahoning counties, where the basal beds of the Pennsylvanian lie less than 100 feet above the Berea The range in thickness of the Mississippian series above the Berea in many counties in southeastern Ohio as determined from well records is as follows:

Athens County	550 to 650 feet
Belmont County	550 to 760 feet
Columbiana County (southern)	200 to 250 feet
Coshocton County	500 to 560 feet
Guernsey County	500 to 700 feet
Jefferson County (southern)	525 to 730 feet
Meigs County	450 to 600 feet
Monroe County	575 to 700 feet
Muskingum County	650 to 700 feet
Noble County	550 to 600 feet
Stark County (central)	300 to 350 feet
Vinton County	550 to 600 feet
Washington County	500 to 640 feet

The Maxville limestone is not known from well records north of an east-west line along the northern boundary of Harrison County and it has apparently been removed by erosion over large areas south of this line. It is also generally wanting on the outcrop except for small scattered exposures

[9]Conrey, G. W *Geol. Survey Ohio*, Fourth Series, Bull. 24 (1921), pp. 49-50.

extending from western Muskingum County to northern Jackson County. The figures given above for the thickness of the series along the outcrop and in the northeastern part of the state apply to the clastic portion only, while in southeastern Ohio these figures include the remnants of the Maxville limestone.

The lower 300 to 400 feet of the Mississippian series above the Berea sand consists for the most part of bluish-gray and black shales, while sandstone is a conspicuous element in the upper half. Immediately overlying the Berea sand there is a thin bed of black shale known as "coffee" shale among the drillers, which represents the continuation under cover of the Sunbury shale. This black shale, which is very persistent, varies from 14 to 60 feet. The changes in thickness, however, are local in nature as no directional expansion is evident from a comparison of well records.

At many places in eastern and southeastern Ohio a sandy zone or "shell" is found from 65 to 100 feet above the Berea sand. This "shell" becomes a well developed sand in parts of Monroe County where it reaches a thickness of 175 feet and is called the Welsh Stray or Weir Sand. A thin sand at the same horizon is present in Jackson County where it is called the Hamden sand, and in Columbiana County where it is known as the Stray sand. The stratigraphic position of this sand suggests that it is correlative with the Buena Vista member of the Cuyahoga formation of surface outcrops.

Over much of southeastern Ohio sandstones form an important element in the 200 to 300 feet of strata immediately underlying the horizon of the Maxville limestone. These sandstones which are correlative with the Black Hand and Logan sandstones of surface outcrops, comprise the Squaw, Big Injun, and Keener sands of the driller. The Squaw sand, which lies at the base of this series, is relatively unimportant as it is thin and irregular in its occurrence. The top of this sandstone series is represented by the Keener sand, which rarely exceeds 60 feet in thickness, where it is best represented in Monroe and Belmont counties. The Big Injun sand, which lies between the Keener and Squaw sands, is the thickest and best known. From a comparative study of well records it appears that the Big Injun sand is well developed over two areas which are separated by a region of thin sandstone and shale. The first area of good sandstone development extends from southern Vinton County to southern Richland and

Ashland counties and lies west of a line passing through southeastern Vinton, eastern Athens, southeastern Perry, western Muskingum, western Coshocton, and western Holmes counties. In this area the sand is quite variable in thickness, but it shows no common directional expansion. Thicknesses of 300 feet or more occur in eastern Knox, western Muskingum, central Hocking, and eastern Vinton counties. The second area lies east of a line extending from central Meigs County through eastern Muskingum and eastern Wayne counties and includes eastern Meigs, Washington, Monroe, eastern Noble, Belmont, Guernsey, southern Jefferson, Harrison, western Carroll, Tuscarawas, western Stark, and eastern Wayne counties. In this portion of the field the Big Injun likewise shows great variation in thickness over small areas, but apparently reaches its best development over Monroe, Belmont, and southern Jefferson counties, where it measures as much as 300 feet.

Separating the two regions where the Big Injun sand is well expressed there is an elongated area including western Wayne, central Holmes, central Coshocton, east central Muskingum, Morgan, and eastern Athens counties in which the Big Injun sand is either wanting or is less than 50 feet in thickness. Apparently the thick sandstones found both to the east and west give way over this elongated area to thin sandstones and shales.

THE BEREA-PITTSBURGH COAL SERIES

In both the Permian and Pennsylvanian systems the horizons which can be correlated over large areas are generally wanting as most of the beds either lack continuity, want definite determinable characteristics, or are too thin to be recognized by the driller. The Pittsburgh coal is a notable exception In southeastern Gallia County the Berea sand lies about 1,800 to 1,900 feet below this coal; in eastern Athens County the interval is 1,380 to 1,480 feet; while in eastern Muskingum County the distance is 1,480 to 1,520 feet. The Pittsburgh coal occurs 1,600 to 1,660 feet above the Berea sand in eastern Noble, southern Monroe, and southeastern Belmont counties The interval decreases to the north along the Ohio River valley, however, for in central Jefferson County is measures 1,400 to 1,460 feet. When the horizon of the Pittsburgh coal is projected north and northwest beyond its outcrop into Columbiana County, the interval to the Berea is

found to be about 1,170 feet in Knox Township, about 1,200 feet in southern Madison Township near Wellsville, and about 1,240 feet near East Palestine in Unity Township. The decrease in this interval to the north, which is most rapid in northern Jefferson and Columbiana counties, is due to the removal by erosion of many feet of Mississippian sediments before the deposition of the Pennsylvanian beds.

SUMMARY AND CONCLUSIONS

From the foregoing discussion it is apparent that the St. Peter-Trenton series, the Trenton-Big Lime series, the Big Lime series, and the Big Lime-Berea series increase in thickness to the eastward in Ohio This eastward expansion is due in part to the thickening of outcropping formations and in part to the presence under cover of certain beds which according to correlations based on a study of well records are not represented on the outcrop Notable examples occur in the Clinton sand and overlying red and gray shales which have not been recognized on the outcrop Either these beds never extended into the region of outcrop or they were removed by erosion before the deposition of the Brassfield (Shell) limestone. In the Big Lime series the salt beds with the associated gypsum and shale are not found to be represented in the outcrops in northern Ohio. A similar condition is present in the Big Lime-Berea series where beds of shale are present under cover both at the bottom and in the upper part of the series, neither of which are represented in surface outcrops of central and southern Ohio.

Of the various series above the St. Peter sand which have been described, the greatest thickening to the eastward occurs in the Big Lime and the overlying shales below the Berea sand These series have their maximum combined thickness of about 5,900 feet in eastern Monroe and southern Belmont counties where the greatest depth of Permian is found Adding 1,650 feet, the interval from the Berea sand to the Pittsburgh coal, and 870 feet, the combined thickness of the Monongahela and Permian strata, it is apparent that the series above the base of the Big Lime has a maximum thickness of about 8,420 feet. The series from the St. Peter sand to the base of the Big Lime likewise thickens to the eastward, but so many local variations occur in the western half of Ohio that the projection of any rate of increase eastward is somewhat hazardous. We believe

it safe to conclude, however, that the series above the St. Peter sand in eastern Monroe County has a thickness of 12,000 to 13,000 feet. Insufficient data prevents any conclusion as to the thickness of the sedimentary series below the St. Peter sand in eastern Ohio.

Radio and the Stars

This book, to quote the author, "is written to bring together recent conspicuous developments in astronomy and its related fields which may suggest a more intimate relationship between man and his cosmic environment than has perhaps been generally supposed." Beginning with the setting in space of the earth with its single satellite, the author considers its various motions, then discusses the observed evidence that latitude does not appear to remain fixed, and that the latitude of a place varies from time to time. This would tend to show that the earth is not absolutely rigid. The cause of the variations is possibly the attraction of the moon which makes our ocean tides and our relatively unsuspected earth tides. Time observations by radio show that such stations as the Naval Observatory, Washington, D. C, and the Royal Observatory, Greenwich, England, vary in their distance one from the other by as much as 63 feet. Again the moon is blamed. Whether or not the earth could lend itself to such bending leads to a consideration of the great value of the sun in our human affairs and then to the relation of sun-spots to the magnetism of the earth. The relation is close and the magnetic storms seem to be started in or by sun-spot activity. The magnetic storms effect radio reception, hence sun-spots effect radio, apparently by ionizing the upper atmosphere in the Kennelly-Heaviside layer, which reflects back our radio signals. The daily lowering and rising of this layer is the cause of night reception being better than day reception Other agencies which influence the ionization of the night sky are considered. Going farther into space Cosmic clouds, clouds of obscuring matter, are encountered. Did they cause glaciation in the past? Geologists feel otherwise for the most part Following Cosmic clouds are considered cosmic rays, those very penetrating rays which seem to come from outside of our own system. With a consideration of Cosmecology, a sort of astronomic ecology, Dr. Stetson concludes his book.

This is a most absorbing book for the non-astronomer, physicist, or geologist, as well as the professional astronomer, because it explains with just enough detail for clearness many of the phenomena, theories and ideas which concern the earth, radio and the stars. We compliment Dr Stetson on the handling of so much complex material in such a delightful manner.—WILLARD BERRY

Earth, Radio and the Stars, by H. T Stetson; xviii + 336 pp. New York, Whittlesey House (McGraw-Hill Book Co.), 1934.

On Understanding Mechanics

As is set forth in the preface, this book is a text to be used in a very elementary course in mechanics Mathematics has been reduced to a very minimum, using only here and there the simplest algebraic relations In the reviewer's opinion the book might be useful in a course in high-school physics or in a college course for beginners who have had no course in high-school physics. For use in high-school courses it would seem especially suitable for collateral reading.

—HAROLD H. NIELSEN.

Mechanics for Beginners, by F. Barraclough and E. J. Holmyard; viii + 214 pp. Toronto, J. M. Dent & Sons.

DRAINAGE HISTORY OF NORTH CENTRAL OHIO

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INTRODUCTION

Incident to a study of the glacial geology of the region in and around the re-entrant angle in the glacial boundary in northeast central Ohio, observations on present and past drainage lines were made in Crawford, Richland, Ashland, Wayne, Morrow, Knox, Holmes, and Coshocton counties. Examination shows, as noted by earlier workers, that many of the present streams flow from low land through higher land; that some large streams flow in small valleys; that some large valleys have no streams; and that, in fact, the present drainage system is a "patch-work" system of streams and valleys of very different sizes and characteristics. As an outgrowth of recent studies of glacial boundaries in the region, the present writer will attempt to show that the position of some of the narrow gorge-like valleys is obviously related to the position of the last Wisconsin ice edge, that some valleys, gorge-like but wider than those referred to the Wisconsin ice margin, are clearly related to the position of the Illinoian ice border, and that still other valleys which are very much wider than those of Illinoian age, but whose streams cross divides through cols and are therefore deranged, have had their courses governed by an early, pre-Illinoian, ice sheet. It is the belief of the present writer that most abandoned valleys, commonly referred to as "preglacial" are only "pre-last glacial" or "pre-Illinoian," rather than "pre-Pleistocene." In fact, the pre-Pleistocene valleys are now so modified that in most cases their location can be only inferred from the pre-Preistocene divides, still well preserved, which indicate ancient drainage basins and which afford clues to approximate locations of the Pliocene streams.

RELIEF AND PHYSIOGRAPHIC DIVISIONS[1]

The region varies from an almost flat plain 950 to 1,100

[1]This brief summary of the physiographic features is given here to aid in making more clear the discussion of drainage history. Detailed study of the geomorphology of the area here discussed and of territory to the north and south is now in progress and the results will be reported in another paper.

feet in elevation in the western part to a maturely dissected plateau 1,200 to 1,500 feet in elevation with a relief of 400 feet in the central and eastern part. A small part of the region, the lower, western part, falls within the Till Plains section of the Central Lowland province as arranged by Fenneman [2] Most of the area, the central and eastern part, which

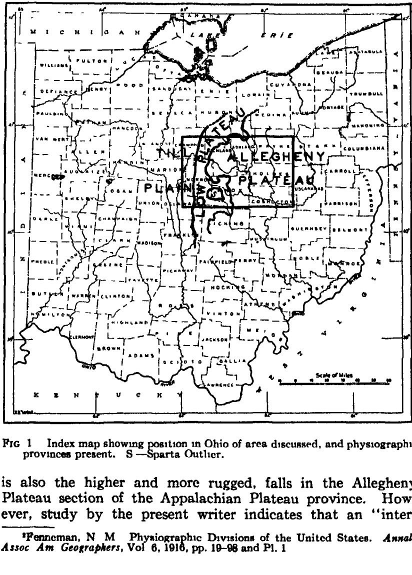


FIG 1 Index map showing position in Ohio of area discussed, and physiographic provinces present. S —Sparta Outlier.

is also the higher and more rugged, falls in the Allegheny Plateau section of the Appalachian Plateau province. However, study by the present writer indicates that an "inter-

[2]Fenneman, N M Physiographic Divisions of the United States. *Annals Assoc Am Geographers*, Vol 6, 1916, pp. 19–98 and Pl. 1

mediate plateau" intervenes between the Till Plain and the Allegheny Plateau. This lower plateau will be referred to here as the "Low Plateau." The location of the three physiographic divisions within the area and the position of the area in the state are shown on Fig 1.

The Allegheny Plateau.—The eastern two-thirds of the area lies in the Allegheny Plateau and is the portion with which this study on drainage history is most concerned This is in the western part of the Allegheny Plateau section of the Appalachian Plateau province which includes western Pennsylvania, the eastern half of Ohio, West Virginia, and eastern Kentucky. In the area under discussion the Allegheny Plateau is dissected to a stage of early to middle maturity, with an average relief of about 200 feet, but locally of as much as 400 feet. It varies in elevation from 1,200 to 1,500 feet, the greater elevation being due to resistant Logan sandstone of Mississippian age and to sandstones of Pennsylvanian age, which here formed a pre-Pleistocene major divide region The concordant ridge tops of the plateau are remnants of a peneplain developed in Early Tertiary time In eastern Ohio the peneplain has been correlated by Stout and Lamborn[3] and in this region by Ver Steeg[4] with the Harrisburg peneplain of Pennsylvania, and by Cole[5] with the Allegheny[6] peneplain of West Virginia. The northern and western parts of the Allegheny Plateau in this area have suffered glaciation, but the southeastern part is unglaciated An outlier of the Allegheny Plateau is present in southeastern Morrow and southwestern Knox counties (see Fig 1). The name "Sparta Outlier" is here suggested for this feature, from the village of Sparta, which is on the western end of the outlier

The Low Plateau—The Low Plateau is the name applied to an area having an elevation of 1,100 to 1,200 feet, lying between the Allegheny Plateau on the east and the Till Plain on the west It is entirely covered by Wisconsin drift. In elevation, in relief, and in prominence of glacial features, this region is intermediate between its bordering regions.

[3]Stout, Wilber, and Lamborn, R E Geology of Columbiana County *Geol. Surv Ohio Bull. 28*, 1924, pp 38-40

[4]Ver Steeg, Karl Some Features of Appalachian Peneplanes *Pan Am. Geol*, Vol. 54, 1930, pp 22-24

[5]Cole, W S. Personal Communication, and, Identification of Erosion Surfaces in Eastern and Southern Ohio. *Jour Geol.*, Vol 42, 1934, pp 285-294.

[6]Fridley, H M, and Nölting, J. P, Jr. Peneplains of the Appalachian Plateau *Jour. Geol*, Vol. 39, 1931, pp 749-755

This physiographic division forms a gently curving belt from 5 to 16 miles in width which lies in Richland, Crawford, Morrow, Knox, and Delaware counties.

Its eastern boundary is marked by the generally abrupt rise of the Allegheny Plateau. Its western boundary is along a scarp that follows the outcrop of the resistant Berea sandstone, which rises from 50 to 100 feet above the Till Plain. The scarp is still further accentuated at places by end-moraines which lie along its top. The Low Plateau extends from this area southward across eastern Delaware and western Licking counties, and although it was not recognized by Fenneman[7] as a physiographic entity, it appears to continue to southern Ohio where it becomes a part of the Lexington plain section of the Interior Low Plateau province. The Low Plateau is part of an erosion surface cut in Late Tertiary time on the weak Cuyahoga shale and shaly sandstones of Mississippian age and is correlated with the Lexington (Worthington) peneplain. The relief of the Low Plateau varies from only a few feet to as much as 100 feet, but averages less than 50 feet. It is covered by a thick blanket of drift so that its topography is glacially controlled.

The Till Plain.—The Till Plain, which covers large parts of western Ohio, Indiana, and Illinois, extends into the western part of the area under discussion, where it forms a north-south belt varying from 8 to 15 miles in width. Its eastern boundary is the edge of the Low Plateau. The Till Plain is featureless except for the low broad swells of end-moraines and for a few large stream valleys cut 10 to 50 feet below the general level. It is a bedrock plain cut on the weak Ohio shale and the soluble Devonian limestone, and covered by a blanket of drift of rather even thickness.

PRE-PLEISTOCENE DRAINAGE

The mapping of the course of the pre-Pleistocene streams in this region is largely hypothetical. The fact that a valley is now mature, or is too wide or too deep for the stream it carries, or is abandoned entirely, does not necessarily indicate that it is preglacial in age. It may have been formed during an interglacial stage and be only earlier than the glacial advance that caused the diversion. The basic postulate in reconstructing

[7]Fenneman, N. M., op. cit.

the pre-Pleistocene drainage is that the streams had become adjusted during the long erosion interval of Mesozoic and Tertiary times and that at the end of the Pliocene the direction of the flow of the streams was the same as that of the slope of the land or, in other words, that the streams were flowing from high land to low land. Therefore, to reconstruct the ancient stream systems, it is necessary to determine the location of the major and branch divides. It may be inferred that streams drained the basins bounded by these divides. If these drainage basins slope from the plateau to the Till Plain, it may be assumed that such systems developed over a long period of time, and that they are the systems which were present at the beginning of the Pleistocene, before the first ice sheet to reach this area disrupted these ancient, adjusted, drainage lines.

The major pre-Pleistocene divide, as shown in Fig. 2, extends eastward from central Morrow County, across southern Richland County, and along the north line of Knox County to Holmes County, and thence in a general east-southeast direction to northern Mechanic Township of Holmes County, where it turns southeast and enters Tuscarawas County. This tracing in the eastern part of the region agrees with that suggested by Coffey.[8] From the major east-west divide other divides extended north and south, thus delimiting the headwaters of drainage basins. One branch divide ran north to southeastern Wayne County. Another had a north-south course in Ashland County east of the present Black Fork, but its connection with the major divide to the south is now obscure because of severe dissection by later streams A third ran from the high land, in south central Richland County west of Mansfield, southeastward to the major divide, but its connection with the main divide has also been obscured by glacially diverted streams.

A very important divide, still well preserved, extended south from the major divide, across southwestern Holmes County and western Coshocton County, about two miles east of the Knox County line. Another extended south across Monroe and Pleasant townships in Knox County southeast of Mt. Vernon, probably reaching northern Morgan Township. From this divide a divide extended west from southwestern

[8]Coffey, G. N Preglacial, Interglacial and Post Glacial Changes of Drainage in Northeastern Ohio with Special Reference to the Upper Muskingum Drainage Basin. *Ohio Jour. Sci.*, Vol. 30, 1930, pp 373–384.

Monroe Township, across the long axis of the Sparta Outlier, into southeastern Morrow County. This latter divide was cut

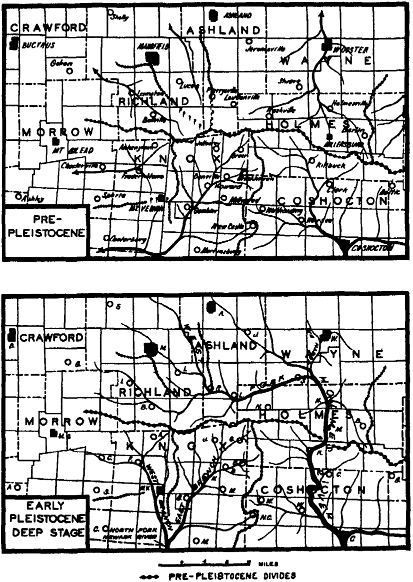
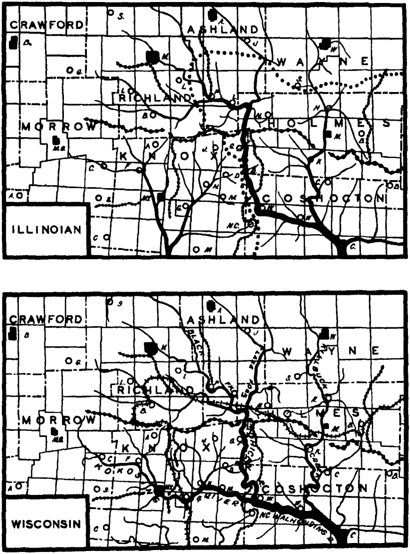


FIG 2. Maps showing Pre-Pleistocene (upper map) and Early Pleistocene (lower map) streams and divides.

through by a wide Deep Stage valley in early Pleistocene time. The Deep Stage valley is now abandoned south of Mt. Vernon.



••• KNOWN ILLINOIAN BOUNDARY ••• POSTULATED ILLINOIAN BOUNDARY —·— WISCONSIN BOUNDARY

FIG 3. Maps showing Illinoian (upper map) and Wisconsin (lower map) streams.

These divides mark out the boundaries of the headwaters of certain basins and, on this basis, hypothetical pre-Pleistocene streams are drawn as shown in Fig. 2. This region, then, had a somewhat radial system of drainage, with streams flowing outward from the highest parts of the Allegheny Plateau.[6]

This system of drainage is probably correlative with the Parker strath system in southern Ohio which was tributary to the Teays River. It is believed that the valley bottom of the Teays was above the present drainage and that the streams in its tributary valleys flowed at levels well above the present streams. As the preglacial streams in northeast central Ohio were all near main divides, their positions were probably still farther above the present water courses. On this basis, the deep valleys in northeast central Ohio are not preglacial. These shallow ancient preglacial valleys have been so cut down, or transected, and so modified by drift in the glaciated portion that they cannot commonly be identified. It must be emphasized that the streams indicated on the map, Fig. 2, are largely hypothetical, especially in the glaciated part of the area and are so mapped because each basin, marked by divides still preserved, must have been drained by a stream flowing from that basin. In the unglaciated part of the region, streams of later age may have had their courses fixed by preglacial valleys, but because of later stream work it has not been possible to identify the preglacial valleys except by inference.

EARLY PLEISTOCENE DIVERSIONS

The preglacial streams which flowed north or west from the region were partly or wholly blocked in early Pleistocene time. New systems of streams were developed which flowed from the Low Plateau southeast into the Allegheny Plateau and across divides to join streams which flowed south, eventually emptying into the newly formed Ohio River. The collected waters broke through the main divide at one place, and the col at Killbuck village is the only early Pleistocene col across the main divide in the area here discussed. Such diversions took place long before the Illinoian glacial stage. In order to explain

[6]Ver Steeg rightly concluded (Drainage Changes in the Vicinity of Wooster, Ohio. *Ohio Jour. Sci.*, Vol. 30, 1930, pp. 309–314) that no *deep* valley leads northward through Wayne county, but the present writer believes that a *high level* (Parker strath) valley must have drained northward since the divides west and south of Wayne county and in the eastern part of the county enclose a basin whose only natural outlet is northward.

them, it is necessary to postulate that an early Pleistocene ice sheet, of which so far no other evidence has been discovered, advanced to the north and west borders of the Allegheny Plateau (Fig. 1). This ice sheet may have been either the Nebraskan or the Kansan of the Mississippi valley succession.

Northward and westward flowing streams were ponded, water broke over the lowest places in divides, and stream courses were established which persisted after the ice withdrew. A long interval of time elapsed between the retreat of this early Pleistocene ice sheet and the oncoming of the Illinoian ice sheet, during which the new streams widened and deepened their valleys. Sufficient time was available for some of the large streams to partially integrate their attendant systems. Valleys were widened to a state of maturity and deepened 150 to 300 feet below the present stream levels.[10]

The pre-Illinoian valleys of this age have been called Deep Stage valleys by Mr. Wilber Stout, State Geologist of Ohio, because of the great depths of their valleys as revealed by well drilling. The name seems appropriate and definitive, and will be used in this report for early Pleistocene, pre-Illinoian valleys. The Deep Stage stream systems of northeast central Ohio are shown in Fig. 2 and will be briefly discussed.

Deep Stage Holmes River.—A Deep Stage stream which drained almost all the northern part of this area is here called the "Deep Stage Holmes River," because its ancient valley cuts across northwestern and central Holmes County. It was brought into existence by pre-Illinoian ice at the north border of the Allegheny Plateau. The dammed up waters escaped southward through the lowest place in the main divide, a col between Millersburg and Killbuck. A wide valley, which may be regarded as the West Fork of the Holmes River, now occupied in part by Black Fork, was cut by a stream which entered the Allegheny Plateau in northeastern Richland County and flowed southeast along the Richland-Ashland county line. Here it entered another valley, now occupied in part by Rocky Fork, which entered the Allegheny Plateau at Mansfield in central Richland County. The West Fork valley continued southeast into Ashland County as far as Perrysville in Green Township, where it received Deep Stage Clear Fork from the

[10] *Cf.* Ver Steeg, Karl The Thickness of the Glacial Deposits in Ohio. *Science*, Vol. 78, 1933, p. 459; and, The Buried Topography of North-Central Ohio and its Origin. *Jour. Geol.*, Vol. 42, 1934, pp. 602–620.

west, then extended eastward past Loudonville to northern Holmes County and thence east-northeast across southern Wayne County to its junction with another large valley now occupied by Killbuck Creek, which may be referred to as the North Fork of the Holmes River. Black Fork now follows the old West Fork valley from Perrysville to Loudonville, but from Loudonville eastward past Shreve this Deep Stage valley is now abandoned. Just north of the junction of the West Fork and North Fork, the latter stream was joined by a large confluent flowing from the northwest, the West Branch of the North Fork. This branch was formed by the union of two streams flowing in the valleys occupied by the present Jerome and Muddy forks, which united just east of the Ashland-Wayne county line and flowed east, through a valley now drift blocked, past Millbrook.[11] The Deep Stage Holmes River thence flowed southward[12] across Holmes County in the valley now occupied by Killbuck Creek through a col, now almost two miles wide, in the pre-Pleistocene divide between Millersburg and the village of Killbuck. Fig. 4-A is a cross-section of this col, and shows its width and depth to be much greater than the Illinoian and Wisconsin cols (Fig 4-B and C). South of the col the Holmes River entered a pre-Pleistocene drainage system unaffected by glaciation and the Holmes flowed south to Coshocton, where it joined tha ancient (Deep Stage) Newark River

Deep Stage Clear Fork —The northwestward drainage from eastern Morrow and southern Richland counties, between the major east-west divide and a branch divide, was blocked. The water found a passage eastward across the high land in Worthington Township, Richland County, and thence flowed northeast across southeastern Monroe Township, joining West Fork of Holmes River at Perrysville. In the main, present Clear Fork occupies this Deep Stage valley. For a distance of three miles near the mouth the old valley is choked with Wisconsin drift, and here the present stream has taken a new course to the south, as discussed below. At Newville, and

[11]*Cf* Conrey, G W. Geology of Wayne County. *Geol. Surv Ohio, Bull 24*, 1921, p. 18

[12]Ver Steeg shows (op. cit) that there is no Deep Stage valley running northward to Orrville as Todd (Some Observations on the Preglacial Drainage of Wayne and Adjacent Counties. *Ohio Acad. Sci*, *Spec Pap. No. 3*, 1900) postulated. In any event, the dammed waters had to escape to the south and the Killbuck col is unquestionably Deep Stage, indicating a large southward flowing stream crossing the divide at this place.

for two miles upstream, the present Clear Fork has been forced slightly north of the Deep Stage valley by Illinoian drift filling

The Deep Stage North Fork of Newark River.—Before the early Pleistocene ice advance, the drainage from northwestern Knox County, and that from southern Knox and southwestern Coshocton counties, was westward. Water dammed up between the east-west divide (Sparta Outlier) near Mt Vernon and the Allegheny Plateau to the north was forced to break across the east-west divide at Mt. Vernon The water flowed into a lake dammed up south of the east-west divide The outlet was

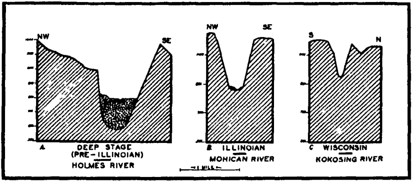


FIG. 4. Sections of cols cut across pre-Pleistocene divides by streams diverted by different ice sheets, showing relation of gorge width to age

A Col of Deep Stage Holmes River (now occupied by Killbuck Creek) across main divide between Millersburg and Killbuck From NE Sec 9, Mechanic Twp to NW Sec 3, Killbuck Twp, Holmes County

B Col of Illinoian Mohican River between Brinkhaven and Greer From NW Sec 15, Richland Twp, Holmes County to S Sec 10, Jefferson Twp, Knox County

C. Col of Wisconsin portion of Kokosing River between Mt Vernon and Gambier. From one-half mile W of Bedell School to one-half mile E of Oak Grove School, Pleasant Twp., Knox County.

established southward to Newark This stream has been called the North Fork of the Newark River by Lamborn,[13] who has studied its Deep Stage valley in detail. He shows that the valley was formed by streams rising in northern Knox County on the southern slope of the major east-west divide and in western Coshocton County on the western slope of the subsidiary north-south divide. The present writer believes that a tributary which flowed eastward past Chesterville in Morrow

[13] Lamborn, R. E. The Newark Drainage System in Knox, Licking, and Northern Fairfield Counties. *Ohio Jour. Sci*, Vol. 32, 1932, pp 449–466.

County, outside the area studied by Lamborn, must have been of considerable size, and must have headed some distance west of the Allegheny Plateau border.

The tributaries to the Deep Stage East Branch of the North Fork that headed at the north-south divide in western Coshocton County can be traced eastward across the present Mohican, therefore this whole Deep Stage system is older than that stream. As the Mohican will be shown to have been forced into its present course by the Illinoian ice sheet, the Deep Stage system must be pre-Illinoian.

ILLINOIAN DIVERSIONS

The position of the ice front of the Illinoian Scioto lobe across this area has been traced in detail and will be described in another paper. Its general location is shown in Fig. 3. One very outstanding and positive drainage diversion caused by the Illinoian ice will be taken up, and then certain other diversions that are less positively attributable to this glacier will be considered.

The Mohican River—The Illinoian ice front lay from one to five miles west of the present Mohican River in northeastern Knox County and continued just east of south across Newcastle and Perry townships of Coshocton County, from one to eight miles west of a pre-glacial north-south divide. The ice dammed the headwaters of the westward and southwestward flowing tributaries to the Deep Stage East Branch of the North Fork of the Newark River and caused the water to flow south across westward extending spurs of the north-south divide, from one headwater basin to the next, as far as southwestern Tiverton Township, Coshocton County. Here a low place in the north-south divide allowed the water to break over to the southeast and enter the valley of the Walhonding River, which then, as now, flowed east-southeast to Coshocton where it united with the Tuscarawas River.

The present Mohican valley southward across Knox and Coshocton counties (Loudonville and Brinkhaven quadrangles) varies from one-fourth mile in width, where it has cut across spurs, to one mile in width, where it crosses Deep Stage valleys. Because of its obvious association with the Illinoian ice front, this valley is regarded as Illinoian in age. Since the stream flows on bedrock where it has cut across spurs and since it cuts across headwater streams of a Deep Stage system, it is not

Deep Stage. The fact, that the Wisconsin diverted streams have narrower gorges (lower Clear Fork, Kokosing between Mt. Vernon and Gambier, and other valleys discussed below), indicates that the Mohican must be pre-Wisconsin. The greater width of one of the typical cols in the Mohican as compared with the width of a Wisconsin col, and the lesser width as compared with that of a Deep Stage col is illustrated in Fig. 4.

The age of the present Kokosing valley in eastern Knox County is as yet undetermined. The valley crosses the old north-south divide area between the villages of Millwood and Walhonding in a wider valley than that of the Mohican. Mr. R. E. Lamborn suggests[14] that a Deep Stage stream which originally headed at the village of Walhonding had, before Illinoian time, worked westward by headward erosion almost to Millwood. If this be the case, a stream may have flowed from the upper part of the East Branch drainage system to the Walhonding River just before, as well as after, Illinoian time. The present writer is of the opinion, however, that only a small stream passed through this col between Millwood and Walhonding until Wisconsin time.

Lake Fork.—Lake Fork now flows from the junction of Jerome and Muddy forks southward across southeastern Ashland County, crosses the Deep Stage valley of the West Fork of the Holmes River in northwestern Holmes County, and thence flows southwest across the south line of Washington Township to the Mohican River (West Salem and Loudonville quadrangles). The valleys of its tributaries, Jerome and Muddy forks, are two to three miles wide and are certainly pre-Illinoian (Deep Stage), but the valley of Lake Fork is only one-fourth to one-half mile wide, except where it crosses the ancient Holmes valley. On this basis it is believed not to be a Deep Stage valley. Its width is, however, greater than that of the valley of Clear Fork in Ashland County, which is canyon-like and which is quite definitely Wisconsin in age. On these bases the Lake Fork valley is believed to have come into existence with the Illinoian ice stage. To block the mouth of the Deep Stage Holmes River in southern Wayne County, and to divert the Deep Stage streams of Jerome Fork and Muddy Fork valleys from their southeastern courses to the Deep Stage

[14]Lamborn, R. E. Personal communication.

Holmes, an obstruction was necessary. It is therefore postulated that a lobe of the Illinoian glacier east of the Scioto lobe extended as far south as Shreve, but not as far as did the later Wisconsin ice, since no Illinoian drift has been discovered in this region south of the Wisconsin boundary. The location of this postulated portion of the Illinoian boundary is shown in Fig. 3.

WISCONSIN DIVERSIONS

The Wisconsin glacier advanced to the limits shown on Fig. 3.[18] Its presence caused several major diversions and many minor changes. When the Wisconsin ice had finally disappeared the streams now present, shown in Fig. 3, were established The Wisconsin diversions will be taken up from east to west across the area.

Doughty Creek.—The headwaters of Martins Creek in southern Berlin Township, Holmes County (Millersburg and Coshocton quadrangles), ponded by the Wisconsin glacier, broke through the main east-west divide in northeastern Mechanic Township, entered Doughty Creek, and flowed southwest to join Killbuck Creek in northern Coshocton County. The course of the stream through the divide is a narrow gorge two miles in length called "Troyers Hollow." Doughty Creek and Martins Creek now rise in an area of terminal moraine topography in central and northern Berlin Township; Martins Creek flowing north from the southeastern part of the township and Doughty Creek flowing south from the northern part, their courses being only from one to two miles apart for a distance of four miles

Sigafoos Run —Sigafoos Run, in the western part of Holmes County (Loudonville quadrangle), suffered diversion of its lower course, which in pre-Wisconsin time was north from Knox Township to the ancient West Branch of the Holmes River in central Washington Township. The Wisconsin ice advanced as far as the south line of Washington Township, blocking the northward flowing stream and forcing it to flow westward, where it cut a narrow gorge for a mile along the front of the ice to the present Mohican River.

Black Fork —After the Illinoian diversion of the West

[18]For details of boundary in Holmes County see White, G. W., Glaciation of Northwestern Holmes County, Ohio *Ohio Jour Sci*, Vol 31, 1931, pp. 429-453; and, An Area of Glacier Stagnation in Ohio. *Jour Geol*, Vol 40, 1932, pp. 238-258.

Branch of the Holmes River, Black Fork followed the Deep Stage valley eastward from Perrysville past Loudonville to northern Washington Township, Holmes County, where it joined Lake Fork and flowed southward (Perrysville and Loudonville quadrangles). A tributary, Pine Run, flowed northeast from southwestern Hanover Township, Ashland County, and entered Black Fork at Loudonville. The Wisconsin glacier front dammed this ancient Pine Run valley two miles southwest of Loudonville The ponded water broke over a divide eastward to the Mohican River[16] and established the present drainage course during the waning of the ice. The lower end of the old Pine Run valley was freed of ice while the old Holmes valley from Loudonville to Lake Fork was still blocked by dead ice masses The present course of Black Fork was therefore established southwestward for two miles up the old Pine Run valley and thence eastward through the new gorge to the Mohican River

Clear Fork—After the early Pleistocene glaciation, Deep Stage Clear Fork flowed eastward through a wide valley from Richland County to join Deep Stage West Fork at Perrysville in Ashland County (Perrysville quadrangle) The Wisconsin ice of the Killbuck[17] lobe at the time of maximum advance covered the lower course of Clear Fork to a point about one-half mile north of Newville in northeastern Worthington Township, Richland County However, the present Clear Fork does not leave its old valley at this place, but follows the old valley eastward along the line between Worthington and Monroe townships and into Section 31, Green Township, Ashland County, to a point only one mile from the Black Fork valley. Here Clear Fork turns southward at right angles, leaving its old valley and entering a canyon-like gorge which it follows southward into northwestern Hanover Township for two miles and thence eastward for three miles to join Black Fork Its course in the old valley along the Worthington-Monroe township line is almost two miles north of the Wisconsin boundary, but its course in the Clear Fork gorge across northern Hanover

[16]Ver Steeg, who has called attention to this diversion (Drainage Changes in the Vicinity of Loudonville, Ohio *Ohio Jour Sci*, Vol 31, 1931, pp 368–377) suggested it might be Illinoian. However, the position of this col, immediately south of the Wisconsin glacial boundary, and its extreme narrowness point to Wisconsin age

[17]Name proposed for the lobe of Wisconsin ice between the "main" Scioto lobe and the Grand River lobe

Township is just south of the glacial boundary. Such a diversion of the stream along the ice front in northern Hanover Township is to be expected, but the absence of diversion in northeastern Worthington Township is not so easily explained. The following hypothesis is offered:

The Killbuck lobe advanced into northeastern Worthington Township and dammed Clear Fork. At first the ponded waters found an outlet through a spillway in the divide at the head of the valley of Smoky Run southwest of Butler in the southeast corner of Jefferson Township, Richland County[18] and escaped into the valley of East Branch of the Kokosing River near Ankenytown. This spillway was not used very long for the Scioto lobe of the glacier advanced a little to the east of Ankenytown to a position just east of the spillway, closing the outlet. By this time, the ice of the border of the Killbuck lobe had melted away from the old valley in northeastern Worthington Township or was fissured and crevassed so that the waters again followed the old course to the southwestern corner of Green Township. However, the ice edge, or more solid ice blocks, kept the water from entering the Black Fork valley, and ponded it to a sufficient height so that it could flow south over the divide into the headwaters of a tributary of Pine Run, and thence eastward along the ice front to the point where Pine Run and Black Fork meet. From here the waters continued eastward, flowing through the new outlet established by Pine Run and Black Fork.

Kokosing River.—The course of the Kokosing River was considerably altered by the Wisconsin ice sheet. The pre-Wisconsin course of the Kokosing was southward from Mt. Vernon to the south line of Knox County, where it joined the East Branch of the North Fork of the Newark River. The Wisconsin ice blocked this valley at its mouth in southern Knox County and ponded waters found egress to the eastward across a low place in the divide at Millwood in southwestern Union Township and joined the Mohican River just east of the Knox-Coshocton county line.

The gorge by which the Kokosing crosses the divide in northwestern Pleasant Township (Gambier quadrangle) is just west of the position attained by the Wisconsin ice front. A cross-section of this Wisconsin gorge is shown in Fig. 4-C.

[18]This spillway appears to be pre-Wisconsin, although the Wisconsin boundary crosses it. It may have been the course of a minor Illinoian stream.

This gorge is explained by supposing that the marginal ice, quite thin on the divide, rapidly disappeared, while ice remained to the south in southern Morgan Township, blocking any outlet to south or east. Water had to escape over the divide between Mt. Vernon and Gambier. There is evidence of a temporary channel immediately to the north of the present gorge (see topographic map and Fig. 4-C). Finally, one channel, probably because it received more water than the other, was cut down faster, and the other was abandoned. The down-cutting was rapid, and by the time the ice disappeared from the region, drainage was established through the new gorge.

Schenk Creek.—Schenk Creek, a former tributary to the Kokosing River at Mt. Vernon, was also diverted by the Wisconsin ice sheet This stream rises in eastern Berlin Township, Knox County, and flows southward along the Wisconsin boundary to northwestern Monroe Township, four miles north of Mt. Vernon (Gambier quadrangle). The Wisconsin ice filled the valley south to Mt. Vernon, and the ponded waters escaped eastward across a divide, along a course now marked by a narrow gorge, into the valley of Little Schenk Creek in northeastern Monroe Township. The water thence flows southeastward to the Kokosing River.

SUMMARY

It has been shown that in the Allegheny Plateau of north central Ohio there are three valley systems which cross ancient divides. The cols are of different widths (Fig. 4) and of different ages.

Narrow gorges closely related to the Wisconsin glacial boundary exist where the Kokosing, Clear Fork, Black Fork, and other streams cross divides. These gorges are believed to date from the Wisconsin glacial stage.

The Mohican River crosses divides in wider gorges, related to the Illinoian glacial boundary, and is believed to have been diverted to its present channel by the Illinoian ice.

Other valleys, where they cross divides, are deep, wide, and mature, and are manifestly pre-Illinoian. Since they cross divides, however, they were cut by diverted streams. An early, pre-Illinoian, ice sheet is believed to have caused the diversion. Valleys of this age are called Deep Stage, the two important systems in the area being the Holmes River (with North and

West forks), and the North Fork (with East and West branches) of the Newark River.

The ancient divides, here mapped (Fig. 2), are believed to mark out basins drained by pre-Pleistocene streams. The actual valleys of these streams were well above present drainage, and have therefore been so cut down, modified, and concealed by glacial drift that their exact location is very uncertain. Based on a study of the pre-Pleistocene divides and drainage basins, which slope northward, westward, southwestward, and southward, the drainage of the plateau in north central Ohio before the Pleistocene was somewhat radial.[19]

[19]ACKNOWLEDGMENTS.—The writer gratefully acknowledges his indebtedness to Professor J. Ernest Carman for many valuable suggestions made during the progress of the field work and during the preparation of most of the manuscript; to Mr. Wilber Stout for many stimulating discussions on the problems of drainage changes in Ohio; to Mr Raymond E Lamborn and to Dr. W. Storrs Cole for suggestions on certain points, and to Mr. John H. Edgerly for drafting the figures.

Cereal, Bamboo, and Grass

"It is now more than thirty years since, at my suggestion, Ethel Sargent sowed the grains of wheat and maize which formed the starting-point of work upon the grass seedling which we did together " "The mystery abides " Thus does Mrs. Arber begin and end her book, but between those two sentences such a multiplicity of material is presented that it will long remain the source-book for those seeking information on the structure of the grasses.

Since there are over 8,000 species in the group it would be impossible adequately to incorporate the vast amount of information already accumulated and in the words of the author: " I have no such encyclopaedic aim, but . have sought, primarily, to detect the pattern and rhythm underlying that complex of plant types called the Gramineae; " Yet this central theme has not deterred her from writing three chapters on the origin and dispersal of the economic grasses; nor has it interfered with a delightful interpolation of "asides," born of a long intimacy with the comparative morphology of vascular plants, without which the book would lose much of its charm and a great deal of its stimulating philosophy.

Although primarily designed for the plant anatomist and morphologist, the book will be indispensable for the agronomist and taxonomist. Neither will the plant geneticist nor the ecologist be disappointed, for they too will find a great deal of solid information pertinent to their fields

It is the culmination of a monumental piece of personal investigation—as evinced by the 212 text figures containing over 1,200 individual drawings and with but few exceptions, done by the author herself It is amply appended with a twenty-one page index and a bibliography of nearly 600 titles.

For the botanist who has any preconceived notions that the problems of plant morphology have been settled, the reviewer specifically recommends Chapter 5, on the "Tree Habit" in the Angiosperms; Chapter 14 on "Morphological Categories;" and the last chapter, on the "Pattern and Rhythm in the Gramineae." They may be disturbing, but they will surely prove stimulating —W. H. CAMP.

The Gramineae, by Agnes Arber, xvii + 480 pp Cambridge, England, The University Press, New York, The Macmillan Co , 1934.

THE RIGHT LUNG OF A HUMAN FOETUS OF 152 MILLIMETERS, C. R., LENGTH

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I. INTRODUCTION

According to the classical accounts, the lower respiratory passages, beginning at the larynx and extending caudally to and including the pulmonary aveoli, develop from a branching diverticulum that has its origin from the entoderm of the floor of the foregut.

The earliest indication of the formation of these respiratory passages in the human embryo is a deep groove that appears on the inner aspect of the ventral surface of the primitive pharynx and oesophagus. Externally the same area presents a longitudinal ridge. Such a stage has been described in an embryo 2 5 millimeters in length by Heiss (1). As development continues the posterior end of the groove becomes a deep globular pocket. This pocket and the posterior end of the groove become a locus of rapid growth and so appear to be cut off from the more dorsally placed foregut. This apparent detachment proceeds in a cephalic direction. The globular pocket evaginates on either side and becomes bilobed. These lateral enlargements are known as the right and left stem buds.

The stem bud is the anlage of the stem bronchus. The latter structure represents the main axis of growth in the developing bronchial system and it becomes the large bronchus, which, arising from the trachea on each side, passes into the hilum and through the pulmonary substance almost to the periphery of the lung. In its course the stem bronchus gives off a series of branches known as the lateral bronchi. These branches arise as evaginations or buds from the region of the growing blind tip of the stem bronchus. The larger and more numerous of these so-called lateral bronchi are given off ventral to the main stem of the pulmonary artery as the latter structure accompanies the stem bronchus. Aeby (2) designated this group of branches as ventral bronchi while other authors have called them lateral bronchi. Smaller and less numerous branches arise dorsally from the stem bronchus and are called

dorsal bronchi. Occasional small branches arising from the stem bronchus in intermediate positions either medial or ventral have been described.

According to Narath (3) three of these branch bronchi are present in a human embryo 7.0 millimeters long. These are the right first lateral bronchus (ventral according to his terminology), the left first lateral (ventral) bronchus and the right apical bronchus. The latter bronchus was regarded as a special type and was termed the eparterial bronchus by Aeby because it arises above the pulmonary artery in contrast to all the other bronchi which are hyparterial in origin. However, Narath held that it was the first dorsal bronchus on the right side. Hungtington (4) states that except for purposes of topography we should abandon the distinction between eparterial and hyparterial bronchi. In this description of the right lung the right apical bronchus will be referred to as D1.

Other bronchi arise successively from the growing stem bronchus until there are four or five lateral bronchi (L1, L2, L3, L4, etc.) and two to four dorsal bronchi, (D1, D2, etc.). All of these are generally classed as secondary bronchi. A new generation, tertiary bronchi or bronchi of the third generation, bud outward from the secondary bronchi. From the tertiary bronchi another generation, the quaternary bronchi develop and in turn a fifth generation of tubules grow out from the quaternary group. Arey (5) quotes Broman as stating that there are in all eighteen generations of pulmonary branchings at birth.

In addition to the evaginations that appear near the tips of the growing buds, new bronchi of the later generations may arise from the blind tips by a splitting of the tip into two or three tubules of the next generation. Since the tubules of the respiratory passages arise by combinations of these methods of formation of new divisions a branching system evolves which becomes more and more like a tree.

While the general plan of development of this tracheobronchial tree is fairly constant, variations usually minor in character may occur. However, Davis (6) states that to his knowledge no other organ has so varied an arrangement of one of its fundamental structures (bronchi).

The budding bronchi grow out into a mass of mesenchyme. This mesenchymal tissue does not contribute to the formation of the lower respiratory passages.

In the last few years the classic concept of the embryology of the lung, so briefly reviewed here, has been questioned by a number of authors—Rose (7), Policard (8), Chiodi (9), Dogliotti (10), Faure-Fremiet (11), Stewart (12). The majority of the conflicting opinions center on the development of the terminal portions of the tracheo-bronchial tree and particularly on the origin and nature of the lining of the atria, air-sacs and alveoli of the adult lung.

Grosser (13) states that a number of important questions concerning the embryology of the human lung have not been settled, partly because the necessary material has not been available. It would seem that a detailed report of the anatomy of the lung of a human foetus just prior to the period of viability might be valuable as a basis for further studies.

In anticipation of a study of the tracheo-bronchial tree in the latter months of the human foetal period the author has examined the tissues of a human foetus which was aborted at about the nineteenth week of prenatal life. These tissues were found to be in an excellent state of fixation.

II. MATERIAL AND METHODS

Material.—Case History: The mother knew that she had been pregnant at least three and one-half months. She was admitted to the hospital with a complaint of vaginal bleeding which had begun following a fall that had occurred three weeks before. However, there were no signs of active hemorrhage on admission. The urinalysis and blood Wassermann test were both negative. On examination the abdomen was found to be somewhat larger than that usually seen in a pregnancy of three and one-half months duration. The foetal heart rate—153 beats per minute was distinctly heard in the left lower quadrant of the abdomen. Seven hours after the admission of the mother to the hospital the foetus was spontaneously expelled. On examination of the foetus the heart could be heard, per stethoscope, but there were no signs of any respiratory movements. A short time later there were no signs of life in the foetus and it was pronounced dead.

The foetus was of the male sex. The skin was moderately firm and no abnormalities were noted. The crown rump measurement or sitting height of the foetus was 152 millimeters. According to the formulae and charts given in standard text-books of embryology, this measurement would place the foetus

in the nineteenth week of prenatal life. The foetus was placed in 10% formalin for forty-eight hours At this time the anterior thoracic wall was partly removed and the pleural sacs opened. Then the foetus was placed in a fresh formalin solution Later the lungs were observed and sketched in situ. In order to avoid many technical difficulties it was decided to make a study of only one lung. The right lung was chosen as the material to be investigated because the more complex problems of morphogenesis have centered on that lung

Methods.—The trachea, primary bronchi, right lung and vessels, thoracic aorta, thoracic duct and thoracic portion of the oesophagus were removed en masse. The tissues were washed, dehydrated and embedded in paraffin. Serial sections of the entire mass, 20 micra in thickness, were prepared and stained with hematoxylin and eosin.

Several wax reconstructions were made by projecting the stained sections upon 2.0 millimeter beeswax plates by use of an Edinger Drawing and Projection Apparatus.

A model of the entire lung magnified to five diameters was constructed to show the distribution of the bronchi. (Plate I). A model of the stem bronchus and the origin of its branches, magnified one hundred diameters was prepared. After the stem bronchus of the lung had been modeled to its termination, one of its end branches was followed along the principal axis to its subpleural termination on the diaphragmatic surface of the lung. As the termination of this branch was approached a three-way branching was encountered. From this point outward all the divisions and subdivisions of this branching were modeled This included an ovoid mass of pulmonary tissue that was separated from the remaining pulmonary tissue as a lobule by thin strands of connective tissue containing branches of the pulmonary vein. Other models of portions of the tracheo-bronchial tree were constructed in attempting to enumerate the number of generations of bronchi that are present in different areas of the lung

The volume proportion of the epithelial tubules to the stroma was determined by projecting representative fields upon sheets of heavy white paper. The tubules were outlined on the paper and the sheet was weighed. Then the tubule outlines were cut out and the remaining paper weighed.

III. MORPHOLOGY

A. THE LUNG AS A WHOLE

The lung was of a uniform yellowish-white color. The chief differences noted in the appearance of this lung and that of an adult right lung were that the foetal lung was shorter from apex to base and that the cardiac impression was relatively large. The superior and middle lobes were continuous for a distance of five millimeters lateral to the anterior border, the transverse interlobar fissure being incomplete in this area and absent on the mediastinal aspect. The fine lobulations of the pulmonary tissue were plainly visible beneath the glistening transparent visceral pleura.

After fixation the lung measured 19 millimeters in vertical height (from apex to center of base). The base measured 26 millimeters in its longest antero-posterior diameter and 16 millimeters in its longest transverse diameter.

B. THE TRACHEO-BRONCHIAL TREE

1. *Trachea and Stem Bronchi.*

(a) The trachea has a position similar to that which it occupies in the adult. It is slightly compressed from anterior to posterior and the posterior surface is flattened. The lumen has a diameter of about 1.7 millimeters. The trachea terminates inferiorly by dividing into right and left stem bronchi (primary bronchi).

(b) The left stem bronchus makes a less obtuse angle with the trachea than does the right stem bronchus. The lumen of the left stem bronchus has a diameter of 1 0 millimeter.

(c) The right stem bronchus passes inferiorly and laterally after its origin at the bifurcation of the trachea. Its borders are rounded with the exception of the posterior which is flattened. Just below its origin the greatest diameter of the lumen is 1.2 millimeters. This stem bronchus gives rise to three dorsal, three lateral, one ventral and two terminal branches. The bronchial pattern formed by the right stem bronchus is as follows: D1, L1, D2, V1, L2, D3, L3, D4 and L4, respectively, from the oral end outward.

As the stem bronchus approaches the medial surface of the superior lobe a large branch is given off laterally. This is the first dorsal bronchus, D1. It arises 4.0 millimeters from the bifurcation of the trachea. The pulmonary artery lies infero-medial to the origin of D1. At a lower level the artery gives off a branch which passes anterior to the stem bronchus, then laterally and superiorly to be distributed with D1. At this second level the main stem of the pulmonary artery lies antero-medial to the stem bronchus

The stem bronchus now passes inferiorly and laterally with the pulmonary artery being found successively antero-medial, anterior and antero-lateral. Both structures now lie well within the hilum of the lung. A large branch, L1, arises from the antero-medial aspect of the stem bronchus about 6.9 millimeters from the angle of bifurcation of the trachea. At approximately the same level a small bronchus, D2, -

arises from the posterior aspect of the stem bronchus and passes postero-laterally into the hilum portion of the inferior lobe.

The stem bronchus now becomes definitely incorporated in the inferior lobe. The next branch arising from the stem bronchus is a large ventral one, V1, which has its origin 8.7 millimeters from the bifurcation of the trachea. The stem bronchus then passes postero-laterally as well as inferiorly. The next bronchus arising from the stem bronchus is a lateral branch, L2. According to Narath the dorsal bronchi are usually fewer in number than the ventral bronchi. L2 arises 10.4 millimeters from the tracheal bifurcation.

A small dorsal bronchus, D3, arises posteriorly from the stem bronchus, 11.9 millimeters from the tracheal bifurcation. At the same level a ventral branch, L3, is given off antero-laterally. After passing posteriorly and inferiorly the stem bronchus terminates by dividing into two bronchi, a smaller postero-medial, D4; and a larger antero-lateral bronchus, L4. This point of termination is 13.0 millimeters from the trachea.

When the right stem bronchus is viewed from above, as from the position of the trachea, a definite spiral curvature is noted in its course. This curvature is clockwise in direction when viewed from the above mentioned position. A similar curvature is present in the course of some of the branches of the stem bronchus, being especially well marked in the fourth lateral bronchus. In the latter case the branches of L4 arise in alternating planes which are at right angles to each other; that is one branch is given off in a transverse plane and the next in an antero-posterior plane.

2. *Bronchi Arising Directly from the Stem Bronchus.*

(a) D1. (Apical Bronchus, Eparterial Bronchus.)—This bronchus arises from the lateral side of the stem bronchus and passes laterally and slightly anteriorly into the hilum portion of the superior lobe. About 0.6 millimeters from its origin, D1 gives off a large posterior branch, D1p, which gives origin to all the bronchi which supply an area bounded by the posterior one-fourth of the costal surface and all of the oblique fissural surface of the superior lobe. (Plate I.) The terminal tubules from this posterior branch reach almost to the apex of the superior lobe. D1 then passes inferiorly and antero-laterally giving off a series of branches. These branches supply the remainder of the superior lobe, namely, an area bounded by the mediastinal, transverse fissural and anterior three-fourths of the costal surface of the superior lobe.

(b) L1. (Bronchus to Middle Lobe—First Lateral Bronchus.)—L1 gives origin to all the tubules found in the middle lobe of the right lung. This bronchus arises from the antero-medial aspect of the stem bronchus as the latter lies in the hilum of the lung. The main stem of the pulmonary artery is lateral to L1 at the point of origin of the latter from the stem bronchus. L1 passes inferiorly, anteriorly and somewhat laterally entering the hilum portion of the middle lobe. At this point L1 gives off a large posterior branch, L1p, then passes downwards and forwards and gives origin to all the bronchi found in the area bounded

by the mediastinal surface, antero-medial four-fifths of the diaphragmatic surface, and anterior two-fifths of the costal surface of the middle lobe. The posterior branch passes downwards, laterally and slightly forwards and supplies all the bronchi found in the remainder of the middle lobe, namely, the area bounded by the postero-lateral one-fifth of the diaphragmatic surface, the lateral three-fifths of the costal surface and by the surface facing into the oblique interlobar fissure.

(c) D2. (Second Dorsal Bronchus.)—This bronchus arises in the hilum of the lung from the posterior aspect of the stem bronchus. The lumen of D2 measures 0.6 millimeter in diameter. The second dorsal bronchus passes postero-laterally into the hilum portion of the inferior lobe about 5.3 millimeters below the most cranial or apical portion of that lobe. D2 arises posterior to the main stem of the pulmonary artery and the branch of that artery which is distributed with D2 lies along the lateral side of the latter structure. D2 almost immediately gives off a posterior branch which gives origin to the bronchi found in the area bounded by posterior half of the costal surface of the inferior lobe from the apex extending downward for about 7.0 millimeters. After giving origin to this posterior branch, D2 continues downwards and laterally giving origin to the bronchi of the inferior lobe in the area antero-medial to that supplied by the posterior branch. The lower limit of the bronchial distribution of D2 may be marked by a line which is almost transversely placed but which is slightly higher along the vertebral margin of the lung and curves across the costal surface to within a millimeter of the oblique interlobar fissure, then turning somewhat upwards to meet the fissure.

A marked similarity is noted in the location of site of origin from the stem bronchus, the branchings and the areas supplied by bronchi D1 and D2. The mass of lung supplied by D2 is in fact a miniature of the superior lobe, which is supplied solely by D1. Such a similarity, although less marked, will be pointed out between bronchi L1 and L2.

(d) V1. (First Ventral Bronchus—Infra-cardial Bronchus.)—This bronchus arises from the antero-medial aspect of the stem bronchus. At the site of origin V1 is medial to the main stem of the pulmonary artery. The lumen of V1 has a diameter of 0.5 millimeter. V1 passes directly downward into the hilum portion of the inferior lobe and gives off a lateral branch, then continues downward into the antero-medial portion of the inferior lobe. The first ventral bronchus supplies all the bronchi found in an area bounded by the mediastinal surface of the inferior lobe below the hilum and by the antero-medial two-fifths of the diaphragmatic surface of the inferior lobe.

(e) L2. (Second Lateral Bronchus.)—This bronchus arises from the lateral portion of the anterior aspect of the stem bronchus. At its site of origin L2 lies medial to the main stem of the pulmonary artery. The lumen measures slightly over 0.4 millimeters in diameter. L2 passes downwards, forwards and laterally and gives off a large lateral branch. Then it continues downwards and forwards. The second lateral bronchus supplies a wedge-shaped segment of the inferior lobe below the level of the hilum. The surfaces of this segment are a vertical strip of the costal surface along the oblique inter-lobar fissure, the

lateral half of the surface facing into the fissure and the antero-lateral one-fifth of the diaphragmatic surface.

In lower animals the lung is clearly made up of a series of supraimposed tiers, each tier being supplied by a dorsal bronchus and its fellow lateral bronchus with the accessory bronchi that may be present at that level In the human lung this system of tiers while not so distinct may still be traced by referring to the various views of the model prepared to show the distribution of bronchi (Plate 1). Each successive tier lies medially, inferiorly and posteriorly to the preceding tier. The first tier has far outgrown the others, forming the superior and middle lobes. The portion of the lung constituting the second tier supplied by D2, V1 and L2 is somewhat of a miniature of the superior and middle lobes supplied by D1 and L1, respectively.

(f) D3. (Third Dorsal Bronchus.)—This bronchus arises from the posterior aspect of the stem bronchus as the latter lies deep in the interior of the inferior lobe. D3 passes directly backwards into the inferior lobe posterior to the main stem of the pulmonary artery. The lumen of D3 has a diameter of 0.2 millimeter. The third dorsal bronchus supplies a wedge-shaped segment of the inferior lobe. This segment is flattened from above downwards and has its base on the middle portion of the costal surface of the inferior lobe.

(g) L3. (Third Lateral Bronchus.)—This bronchus arises from the antero-lateral aspect of the stem bronchus medial to the main stem of the pulmonary artery. The lumen of L3 measures 0 4 millimeter in diameter. L3 passes downwards and laterally, gives off a postero-lateral branch and then continues downward The third lateral bronchus is distributed to a wedge-shaped segment of the lower half of the inferior lobe. This segment borders on the postero-lateral portion of the costal surface and on the postero-lateral one-sixth of the diaphragmatic surface of the inferior lobe.

(h) D4. (Dorso-Medial Terminal Branch of Stem Bronchus.)—The lumen of this bronchus measures 0 4 millimeter in diameter The bronchus passes postero-laterally and inferiorly and is distributed to a tetrahedronal segment of the lower half of the inferior lobe The base of this segment is on the postero-medial portion of the costal surface.

(i) L4. (Antero-Lateral Terminal Branch of Stem Bronchus.)—The lumen measures 0 6 millimeter in diameter L4 passes inferiorly and is distributed to a wedge-shaped segment of the lower half of the inferior lobe. This segment borders on the most convex portion of the costal surface and on the posterior one-fifth (approximately) of the diaphragmatic surface

3. *Branches Arising from the Direct Branches of the Stem Bronchus.*

It seems questionable whether all the direct branches of the stem bronchus should be classed as secondary bronchi The report of Narath on the morphology of the bronchial system in a human embryo of 7 0 millimeters in length seems to justify the application of the term secondary bronchus or bronchus of the second generation to D1 and L1 since they apparently arise proximal to the growing tip of

the stem bronchus. Whether the remaining branches of the stem bronchus should be classed as secondary bronchi remains a problem until a larger series of early human embryos have been studied. This same lack of a more complete series prohibits the classification of the branches of D1 and L1 as secondary stem bronchi with tertiary branches although such a pattern seems to be common to each of them. However, in each of these bronchi the first branch is a posterior one and is almost as large as the parent secondary bronchus which continues on from the site of origin of the branch. From the bronchi arising from the stem bronchus and from the branches of these bronchi many generations of tubules arise. As yet there seems to be no exact way of determining what generations of these will develop into the bronchi and bronchioles of the adult lung. Following the example of Kolliker (14) we may denote all the branches as tubules. The determination of the exact number of generations of tubules present in the simple tracheobronchial tree of a young embryo is a difficult problem, and the difficulties are greatly multiplied in the study of the tree in a foetus in the nineteenth week of prenatal life. It is fairly well agreed that new tubules may arise by any one or by combinations of three methods, namely, lateral budding (monopodial), dichotomous branching and trichotomous branching. No definite regularity in the appearance of these methods of tubule formation has been described. Furthermore, in examining an embryological specimen it should always be remembered that the growth processes may have obscured the forms of an earlier stage. A dichotomous branching may later appear to be a larger bronchus giving off a smaller side branch due to more rapid growth in one of the pairs of bronchi previously formed by the dichotomous division.

It is apparent that a definite rule is necessary before determinations of value can be obtained Accordingly the following rules have been observed in making the determinations of the number of generations of tubules present in the different lung areas listed First, some type of reconstruction or models should be prepared from a complete set of serial sections. A model is necessary so that no branches will be overlooked, and is especially desirable in studying the finer ramifications where new tubules arise from many aspects of the parent stems

Second, when tracing along a tubule and its first branch is encountered, that branch should be given a number denoting the succeeding generation. Then this branch is traced along its course and the tubule previously being traced is disregarded This branch is followed until its first branch is found and then this latter branch is given a number denoting another generation and it is followed, etc. If a division with branches of equal size is found, the one that is distributed to the more orally located area is assumed to be the branch.

This method seems reasonable and necessary because it is an assumption to treat a small bronchus as a branch of a large bronchus in every case, whereas the two may have at an earlier period been fellow members of a dichotomous branching, after which one (the assumed main bronchus), grew more rapidly. Using these rules the following results were obtained:

Superior Lobe.—Considering D1 as a secondary bronchus (generation 2) there are sixteen generations of tubules present.

Middle Lobe.—Considering L1 as of generation 2 there are seventeen generations of tubules present. In the particular region examined the seventeenth generation was just in the process of formation, being represented as paired evaginations of the blind end of the preceding tubule, (generation 16).

Inferior Lobe.—The number of generations of tubules arising from the remaining dorsal bronchi was determined by the same method. If these bronchi (D2, D3 and D4) are considered as bronchi of the second generation the results are: D2, 15 generations; D3, 14 generations; D4, 13 generations. It is interesting to note the progressive decrease in the number of generations from the successive dorsal bronchi. It suggests a correlation with the tier structure of the lung that is so much more apparent in lower animals. However, D2, the dorsal representative of the second tier, may be considered a bronchus of the third generation and then the number of generations in this area will be 16, the same number as was found in the area of D1.

The first seven or eight generations of bronchi lie within definite connective tissue septa while the remaining generations lie within and largely make up the areas inclosed by less distinct septa.

C. LUMINA

In the first seven or eight generations, whose walls are rigid, the margins of the lumina are markedly serrated due to the longitudinal foldings of the inner coats of the bronchi. In the remaining generations the lumen is small but usually distinct. The lumen in these latter tubules is greatest at the site of origin of branches and at the blind ends of the tubules. These terminal expansions do not appear to be as large relatively as the terminal buds observed at earlier periods in the development of the tracheo-bronchial tree. Merkel (15) quotes Kolliker as stating that air-cells begin to be formed in the sixth month of foetal life and that in the beginning of the fifth month the end buds measure 0.09 to 0.13 millimeter in diameter.

In this foetus the following diameters were found for the lumina of two sets of generations of bronchi: (diameters in millimeters).

Generation	D1	L1	Generation	D1	L1
2	.70	.60	10	.08	.08
3	.41	.46	11	.07	.06
4	.29	.35	12	05	.06
5	.26	.28	13	.05	.05
6	.18	.14	14	.03	.03
7	.11	.12	15	.03	.03
8	.09	.09	16	.04	.03
9	.09	.09	17	...	.03

These measurements are of only one successive line of tubules in the respective areas. The size of the tubules of one generation is variable among the larger tubules but the terminal generations are of a uniform size throughout the lung, the lumen averaging about 0.03 millimeter and the entire tubule 0.05 millimeter in diameter.

D. BLOOD VESSELS

1. *The Pulmonary Artery.*

The right branch of the pulmonary artery passes directly laterally from its origin and then turns downward in front of the stem bronchus at a point just inferior to the origin of bronchus D1. The lumen of the artery has a diameter of 1.4 millimeters. Corresponding to the bronchi the main arterial trunk or stem artery gives origin to a branch for each bronchus that arises from the stem bronchus. The arterial branches arise at a slightly higher level than the bronchi which they accompany but are given off in a plane exactly parallel to the plane in which the bronchus arises. The arterial branches pass outward on the lateral aspect of their corresponding bronchi.

2. *The Pulmonary Veins.*

The small venous channels lie between the pulmonary lobules. The upper pulmonary vein drains the superior and middle lobes, the vein from the superior lobe passing anterior to both the stem artery and the stem bronchus while the veins from the middle lobe converge to form a trunk that lies medial to the first lateral bronchus. The lower pulmonary vein, draining the inferior lobe, lies posterior to the stem artery and the stem bronchus.

3. *Bronchial Vessels.*

The bronchial arteries are very small and together with the bronchial veins are found lying on the posterior aspect of the stem bronchus.

E. LYMPH GLANDS

There are two tracheo-bronchial lymph glands present, the largest measuring 1.1 by 1.8 millimeters in cross-section. There were probably other members of this particular group of glands that were not removed from the thorax. There are four intertracheo-bronchial glands (glands of the bifurcation) and nine broncho-pulmonary glands present. No members of the pulmonary group of lymph glands were observed.

F. NERVES

The right vagus nerve lies longitudinally along the right postero-lateral aspect of the trachea. From this nerve a large branch passes along the posterior surface of the stem bronchus into the hilum of the lung. Here it breaks up into smaller branches which accompany the bronchi arising from the stem bronchus. Nerves could not be traced beyond the fifth generation of tubules. A specific nerve stain was not employed. One or two other small nerves are present in the outer wall of the stem bronchus, but their exact origin was not determined.

IV. HISTOLOGY

A. THE TRACHEO-BRONCHIAL TREE

1. *Epithelium.*

The epithelium of the oral end of the tracheo-bronchial tree is of a ciliated pseudo-stratified columnar type containing the same four types-

of cells as the epithelium of the adult trachea; namely, basal, intermediate, ciliated and goblet cells. A typical cuticular border is present. The goblet cells are few in number and are apparently immature, being more nearly the shape of a spear-head than that of a goblet. Over the free surface of the goblet cell the cuticular border dips in away from the lumen and cilia are absent. No goblet cells were observed that were in the process of extruding mucin. Goblet cells are not found below the origin of bronchus L2.

This ciliated pseudo-stratified type of epithelium lines the entire extent of the stem bronchus and continues out along the branches of the tracheo-bronchial tree as far as the sixth or seventh generation of tubules. In these generations the intermediate cells are not numerous and soon disappear entirely. From the sixth or seventh generation to and including the tenth generation the epithelium is ciliated pseudostratified consisting of two cell types, the pyramidal basal cells with irregular smaller darkly staining nuclei and scant cytoplasm and the slender ciliated cells with oval or flattened nuclei placed at right angles to the cuticular border. These ciliated cells extend down between the basal cells with tapering ends and the cytoplasm is more abundant at the cuticular pole of the cell.

The epithelium is not ciliated beyond the tenth generation of tubules. In other respects it is like that of generations 6 or 7 to 10 as far as generation 13. In the case of both D1 and L1 the origin of generation 14 is marked by an abrupt change of the epithelium to a simple cuboidal type. In vertical section the outline of these cells is practically square. The nucleus is large, round and centrally placed with fine scattered chromatin granules. The cytoplasm takes a moderate amount of stain and appears structureless. In generations 15, 16 and 17 the cytoplasm is more abundant, seems rarefied, stains lightly, and the nuclei are much more vesicular. This peculiar condition of the cells of the smaller tubules has been noted by Dogliotti and Amprino (16).

In all the regions examined throughout the entire tree the epithelium forms a continuous lining from trachea to the blind ends of the terminal generations. At no point was there any evidence of a break in the epithelial lining or of local death of tissue. No areas were observed in which parts of the lining cells were being desquamated.

2. *Basement Membrane.*

The basement membrane of the oral end of the tree is thicker than in the smaller divisions. The epithelial cells rest directly on the reticulum fibers of the stroma throughout the extent of the tubular system, and the basement membrane is intact throughout.

3. *Glands.*

The tracheal glands are very numerous and are of a compound tubulo-alveolar type. In the alveoli two types of glandular cells are found, namely, cuboidal granular cells of a serous nature and columnar mucin containing cells. In the trachea typical crescents of Giannuzzi were noted. The ducts, near the alveoli, are lined with a cuboidal epithelium, but the lining becomes pseudostratified near the orifices of the ducts. The stem bronchus contains fewer glands than the

trachea and the alveoli of the glands consist almost entirely of serous cells. As the branches of the stem bronchus are followed outward, glands are present as far as and including the seventh generation. In the smaller tubules many of the glands are still in a simple tubular stage.

4. *Cartilage.*

In the trachea several of the C-shaped rings are completely formed, while in the bronchi the cartilage is present in the form of plates. The cartilage extends out as far as and including the eighth generation of branchings.

B. STROMA OF THE LUNG

The stroma consists of fibroblasts rather loosely and irregularly arranged between the tubules. In the walls of the first eight generations of bronchi, chrondoblasts and the appearance of cartilage are noted. There is no particular condensation of the stroma about the walls of the remaining generations of tubules. The stroma lying between the terminal ramifications is quite avascular This observation is contrary to that of Rose, but is supported by the studies of Dogliotti. A high power microscopic field of the lung tissue resembles that of a compound tubular gland in many ways, although the stroma is relatively great in amount in the lung at this stage. Studies of areas in which no large bronchi or vessels are present show that the stroma makes up about 79% of the mass of the pulmonary tissue. Free cells are very occasional in the stroma and seem to be of the cell type usually described as clasmatocytes.

C. LYMPH GLANDS

The largest of the lymph glands have a typical peripheral sinus but there are no secondary nodules or "germinal centers" present. The gland is made up of closely packed cells which appear to be large lymphocytes for the most part. However, there are considerable numbers of free polymorphonuclear cells. The lymph glands appear relatively vascular.

No peculiar histiologic characteristics at this stage were noted in the other structures described in the section on Morphology.

V SUMMARY

1. The bronchial tree of a human foetus of 152 millimeter length (c r.) has a continuous intact lining of epithelium.

2. According to a method of enumeration outlined, there are seventeen generations of tubules present as a maximum number In such a location the first thirteen generations are lined by a pseudo-stratified epithelium, the remaining four generations have a cuboidal epithelium

3. In the terminal generations of tubules (last two or three) the epithelial cells are relatively large, with round vesicular nuclei and abundant cytoplasm that appears to be rarefied.

4. The terminal tubules have a diameter of 0.05 to 0.06 millimeter.

5. The more oral the site of origin of a branch bronchus from the stem bronchus the greater the number of generations of tubules that have arisen from this branch bronchus.

6. When viewed from above, there is a marked clock-wise rotation of the stem bronchus in its course.

* * * * * * * * *

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EXPLANATION OF PLATES

PLATE I

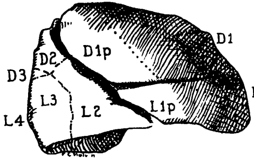
Right Lung. Surface areas of bronchial distribution. Lateral, Dorsal, Medial and Diaphragmatic views of a wax reconstruction.

Areas: D1, First Dorsal Bronchus except its first branch which is indicated by D1p. L1, First Lateral Bronchus except its first branch which is indicated by L1p. Other dorsal bronchi, D2, D3 and D4 Other lateral bronchi, L2, L3 and L4. V1, First Ventral Bronchus (Infracardial bronchus). Tr., Trachea. RSB, Right Stem Bronchus. × 2.

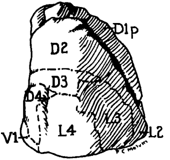
PLATE II

Semidiagramatic sketches of epithelium of tracheo-bronchial tree.

G, Goblet cell; CI, Ciliated cell; I, Intermediate cell; B, Basal cell; CO, Nonciliated columnar cell; CU, Cuboidal cell; L. CU, Light-staining cuboidal cell. × 550.



Lateral



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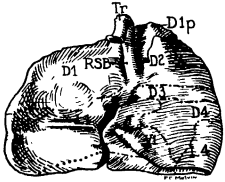

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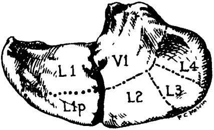
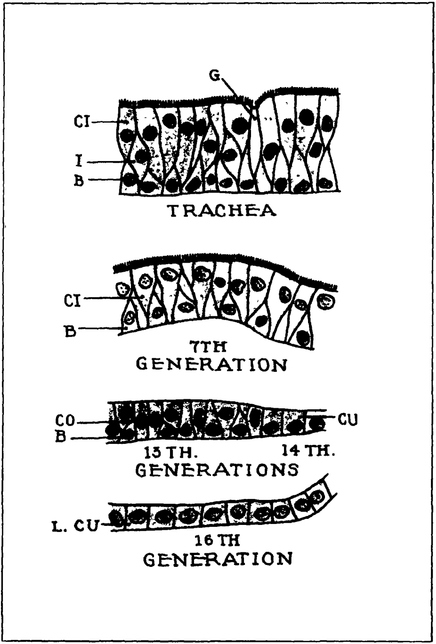


Diaphragmatic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THE EMBRYOLOGY OF THE WHITEFISH *COREGONUS CLUPEAFORMIS*, (MITCHILL)

PART II. ORGANOGENESIS

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FOREWORD

In the first paper of this series,[1] the early embryology of the whitefish from fertilization up through the closure of the blastopore (Stage 128, O. S. U. series) was described. The later stage marked the completion of the first third of the incubation period in terms of thermal units, although the embryo had been incubated only one-sixth the number of days usually required by this species before hatching in lake water of winter temperatures. The embryo was about 3 mm. long, and it lay without torsion and clearly outlined over the curvature of the yolk. In its anterior end, the three primary brain lobes were present and the neural keel of the head region lay deeply imbedded in the yolk. The optic primordia were prominent, lateral to the forebrain and were attached to the latter by broad optic stalks. Neither the brain nor the optic anlagen possessed cavities in this stage and hence have not yet acquired the vesicular condition. A thickened ectodermal plate lay on each side of the neural keel lengthwise. This sensory plate possessed an indistinct sensory furrow. The notochord had extended its full length forward to end beneath the midbrain. Eleven pairs of somites were present, with the most anterior one lying at the level of the hind brain. The entoderm was described as being thin and unfolded throughout its length. Kupffer's vesicle was seen here in its stage of maximum size.

From this condition as a point of departure, the present paper describes the general embryology and development of the whitefish up through Stage 400 of this series, which marks the completion of the first half of the incubation period.

Stage 144. O. S. U. Series.—(Incubation period, 24 days, 20 hours; 112.5 T. U.; fourteen pairs of somites.) The embryo lies as in the

[1]The Embryology of the Whitefish. Part I. Early Embryology. Ohio Jour. Sci., Vol. XXXIV, No. 5, 1934.

previous stage prominently elevated above the yolk surface, without torsion. It now extends about one-half the distance around the curvature of the yolk. Marked cephalization is expressed in the prominence of the three primary brain lobes and of the optic vesicles. The latter are now well developed sac-like structures whose walls are composed of a single layer of columnar cells. The cavity within is confluent with a small one within the brain stem which appears in this stage for the first time as the result of continued delamination and final separation of the cells of the neural keel in that region. This cavity is the third ventricle. Elsewhere in the brain region, the cells are not definitely separated, but their nuclei are drawn out to the sides of the keel, and their inner ends are interlocked. Their nuclei thus form two distinct rows, one on each side of the mid-line. The central portion of the sensory plate has become invaginated at the level of the hind brain to form a thick-walled auditory pit, with a small central canal. A thickened ectodermal plate lays anterior and continuous with it to form the pre-auditory sensory plate. In the posterior end of the notochord, the cells are definitely wedge-shaped and interlocked. Their nuclei are migrating laterally toward the periphery, preparatory to vacuolation of the notochord. The entodermal sheet retains its unfolded condition forward to the branchial region at the level of the first anterior somite. Anterior to this level it becomes folded on itself dorso-laterally to form a conspicuous branchial fold on either side. However, the floor of the pharynx is incomplete in the mid-line. Just anterior to the auditory pit, this projects distally as a pouch to meet a plate of surface ectoderm on the side of the head to mark the location of the first branchial cleft. Just anterior to this, the hyomandibular pouch extends more vertically, but does not reach the surface ectoderm. From this point forward the branchial folds flatten out and the pharynx ends just beyond the end of the notochord. Lateral to the branchial folds on either side lies a sheet of splanchnic mesoderm which is folded inward to enclose minute paired pericardial cavities. The cells on the mesial border of these folds are somewhat elongated. Inward from them lie clusters of cells derived from intermediate mesoderm, which are destined to form the endocardial lining of the heart.

Stage 160. O. S. U. Series.—(Incubation period, 27 days, 12 hours; 115.1 T. U.; 21 pairs of somites; total length of embryo, 3.5 mm.)

The embryo has undergone an orderly increase in length and in the number of paired somites during the two and a half days of incubation since the previously described stage. The brain has increased in size, with thicker walls. The third ventricle is more pronounced in the surface view, and now extends as a narrow cavity above the floor of the prosencephalon throughout its length. The optic vesicles likewise are larger than in the previous stage. They have now become laterally compressed and invaginated to form a two-layered optic cup. The elongated columnar cells which line the cup to form the thickened retinal layer are now separated mesially from the thinner peripheral layer of cells by a narrow cavity, confluent with that of the optic stalk and third ventricle. Ventrally, the optic cup is indented by the choroid

fissure, which is formed as the result of the invagination of the cup, and which persists until after the hatching stage. The small area of surface ectoderm which covers the center of the optic cup is thickened at this stage to form the primordium of the lens A slight invagination of a thickened ectodermal placode on each side of the mid-line, on the antero-ventral surface of the head marks out for the first time the location of the nasal pits. The auditory pit, described in the previous stage, has sunken further beneath the surface and now forms the auditory vesicle, whose thick walls are composed of a single row of columnar cells concentrically arranged. Its mesial surface comes to lie in close proximity to the sides of the hind brain The branchial folds, first described in the previous stage, are more conspicuous in cross-sections than before. The hyomandibular pouch now is in contact with a thickened ectodermal plate on the outer surface of the head. The first branchial pouch immediately behind it clearly extends to the surface ectoderm, laterally beneath the anterior portion of the auditory vesicle. Cross-sections at these levels closely approximate the conditions shown in Figures 56 and 59, Plate XVI—Swaen *et* Brachet—1900. Anterior to the hyomandibular pouch the entoderm has folded on itself to complete the floor of the pharynx in the mid-line by a thin strand of cells. The pharynx ends blindly as before.

The endocardial masses from each side slightly in advance of the level of the auditory vesicle have met each other in the mid-line beneath the enclosed portion of the pharynx, forming a single, loosely connected endocardial mass. The folded layers of splanchnic mesoderm bounding the pericardia have accompanied the endocardial masses in their migration inward and now lie ventro-lateral beneath the pharynx. See Fig. 16, Pl. XVII, Swaen et Brachet, v. 16.

There are apparently 21 pairs of somites present. In the anterior somites particularly, the cells on the ventro-mesial border are assuming the mesenchymal characteristics of the sclerotome. The latter lies adjacent to the notochord.

In Stage 112, the intermediate mesoderm in the region of the anterior somites was described as a single line of cells which at that time lies between the somite and the lateral mesoderm Now these cells have increased in number, have migrated ventrally and form a wedge-shaped mass ventro-lateral to the sclerotome and dorsal to the entoderm. These masses of intermediate mesoderm will later complete their migration from each side and occupy the space in the mid-line beneath the subnotochordal rod, there to give rise to the blood and definitive vessels in this region.

In Teleosts, the intermediate mesoderm is not segmented, and hence the primitive excretory organ does not form as a series of pronephric tubules but rather as a single pronephric chamber.

At the level of the 4th, 5th, and 6th somites, a secondary plate of intermediate mesoderm, which has not migrated as above but has retained its primitive position on the mesial face of the lateral mesoderm, gradually becomes differentiated from the latter to form the pronephric chamber. This differentiation appears first as a thickening of this plate. Its ventral mesial border becomes folded sharply to grade imperceptibly-

into the splanchnic layer of the lateral mesoderm. Later, when the cavity of the splanchnocoele forms, it will penetrate between the folded cell layers of this plate to form the lumen of the pronephric chamber. From the level of the 7th somite backwards, the cells of the secondary intermediate plate become constricted off from the mesial face of the lateral mesoderm to form a solid cord of cells which appears as a rosette in cross-sections. This line of cells becomes the pronephric duct, after it acquires a lumen, and extends to the anus. At the present stage, number 160, the first steps in the differentiation of the pronephric chamber and duct have occurred. At the level of the 4th, 5th, and 6th somites, the primitive plate of intermediate mesoderm is thickened and its ventral mesial border is drawn slightly downward and inward. Its cells are compressed, and no cavity is present. The line of cells marking off the pronephric duct can be traced in these sections from somites 7 to 12. The lumen of this duct has likewise not yet formed. The development follows the description of Swaen and Brachet (1900) and is slightly less advanced than is figured by them in Figures 17, 18, and 19, of Plate XII.

In the angle on each side of the body opposite the first anterior somites there is a longitudinal furrow paved with columnar epithelial cells. At the intervals between somites, these cells form a conspicuous cluster. Anterior to the first somite this thickening swings dorsally and approaches the auditory sac. Whether this line of cells represents an early stage in the development of the lateral line, or whether it is simply due to other and unrelated development of the surface ectoderm, the author is unable to determine at this point.

Stage 176. O. S. U. Series.—(Incubation period, 30 days, 4 hours; 117.8 T. U.; 24 somites.) The degree of development in this stage of the brain and sense organs is not significantly different than that described in the previous stage. The cells of the brain and nerve cord are now regularly disposed throughout the length of the body along the lateral margins and are separated by a narrow line throughout the dorsal portion. The canalis centralis extends the length of the nerve cord near its floor. In sagittal sections, a mass of head mesoderm is seen in the same relative position as that described in Stage 128. It is now larger and triangular in shape. The apex of the triangle is near the superficial ectoderm on the lateral margin of the head. In the branchial region, the auditory vesicle, branchial folds and endocardium have developed to a slightly more advanced stage but their relationships are essentially the same as in the previous description. The folds of the gut rapidly diminish in extent in the esophageal region, and merge into an unfolded sheet of entoderm at the level of the 2d. somite. A minute lumen appears between the entodermal cells in the mid-line opposite the middle of the 3d. somite, and continues for the length of almost five somites. Sclerotome formation is more advanced in the anterior somites but can be traced for at least 15 somites. Temporary cavities are present in the sclerotomal masses of the first five or six somites. The primary plates of intermediate mesoderm which are the primordia of the axial blood vessels retain the position described in Stage 160, ventro-lateral to the sclerotome and dorsal to the entoderm. These

wedge-shaped masses extend in toward the mid-line particularly between the somites. From the 6th to the 9th somite level a few cells have reached the mid-line and penetrate the cavity beneath the subnotochordal rod. This condition is less distinct at other levels.

The degree of development of the pronephric chamber is only slightly more advanced than described in the preceding stage. The primordium of the pronephric duct still lacks its lumen but can be traced from somites seven to eighteen.

The ectodermal thickenings along the sides of the body can be located in sections on the side of the trunk opposite the divisions between somites backward as far as the interval between the 7th and 8th somites.

Stage 192. O. S. U. Series.—(Incubation period, 32 days, 20 hours; 119.5 T. U.; approximately 28 somites.) The mid-brain is now divided into two distinct optic lobes separated by a conspicuous Sylvian aqueduct, and the hindbrain is differentiated into the metencephalon and myelencephalon. The walls of the brain stem in this area have become thickened, and the fourth ventricle appears for the first time with this stage. The optic stalk is more constricted than described in Stage 160. The conditions through the middle of the body are the same as described for the previous stage, with the following modifications. The intermediate cell masses still lie ventral to the sclerotome on either side but are composed of a larger number of cells and hence are more prominent. More cells than before have migrated from this mass into the mid-line beneath the subnotochordal rod. There are approximately twenty-eight somites present. The primordium of the pronephric duct may be traced from the seventh to the twenty-second somite.

The tail is distinctly raised above the yolk, and the tail fold is beginning to undercut it.

Stage 208. O. S. U. Series.—(Incubation period, 35 days, 12 hours; 123.14 T. U.; 32 somites.) The fore-brain is now differentiated into telencephalon and diencephalon. The infundibulum is present here in its initial stages of development as a slight thickening beneath the floor of the diencephalon, adjacent to the point of emergence of the optic stalk. The blind anterior end of the pharynx is immediately posterior to the infundibulum. Here both the upper and lower layers of the pharyngeal wall extend laterally and are in continuity with the surface ectoderm on the side of the head. Both the hyomandibular and first branchial pouches are definitely in contact with the slightly invaginated surface ectoderm. The first branchial pouch extends diagonally from just before the auditory pit, backward and downward beneath it. Midway beneath the auditory pit the pharynx rounds up sharply into the gut which possesses a lumen for a short distance. Posteriorly, the entoderm is a highly arched layer in the mid-ventral line whose lower edges have not yet fused, and which is flattened out progressively caudad. The endocardial primordium lies as a single mass of loosely connected cells beneath the pharynx backward to the level of the first branchial pouch. It is somewhat more sharply delineated from the epimyocardial folds than described in Stage 160. The epimyocardial folds likewise are more thickened in cross-section than in the former stage.

The pronephric ducts may be traced from somites seven to twenty-two as before. There are 32 somites present. Posterior to the last somite there extends a non-segmented mesodermal mass backward to the level of Kupffer's vesicle, which lies beneath the caudal end of the notochord.

Stage 224. O. S. U. Series.—(Incubation period, 38 days, 4 hours; 125.8 T. U.; total length of embryo, 4.2 mm.; 39 somites.—Reconstruction drawing, Plate III.)

The reconstruction drawing of this stage may be directly compared with that of Stage 128, Plate II, in the first paper of this series. It is seen that the embryo has increased more than one-third its former length in the interval between these two stages. By this time it has passed through a little more than one-fourth its total incubation period, in point of time (38 days out of a total of 134 days), and one-third of its incubation period in point of thermal units (126 T. U. out of a total of 345 at hatching). Its present length of 4.2 mm. is likewise about one-third of its hatching length, (12 mm.). It is of significance that in this first third of its incubation period, every major organ system and structure present at hatching with the exception of the paired pectoral fins has been definitely laid down. The embryo at this time is clearly outlined on the surface of the yolk. It extends without torsion over approximately one-half of that surface, and its anterior end is somewhat imbedded in it. The conspicuously large brain and sense organs, particularly the eyes, indicate a precocious development in that region.

The definitive brain lobes, including the infundibulum, are established and can be distinguished in the whole mount. The nasal pit is in the form of an elliptically invaginated sac, lined with columnar epithelium, on the antero-lateral angle of the forebrain. The prominent eye possesses a well-developed circular lens centrally placed, and the optic nerve is seen to extend forward from the mesial-ventral surface of the eye to enter the diencephalon at the anterior end of the infundibulum. The head is imbedded in the yolk up to the level of the lens. Extending over the yolk laterally from this point is a sheet of extra-embryonic somatopleure shown in the drawing as a lightly stippled band.

The brain has greatly increased in width, particularly in the region of the medulla oblongata, where it is much broader than deep. This widening process has brought about a great expansion of the fourth ventricle, which is very conspicuous from the dorsal view. Triangular in shape, its area is approximately equal to that of the remainder of the brain. The choroid plexus which covers its roof is seen in the drawing to be clearly separated from the underlying nervous tissue. Laterally, the auditory sac is a rounded invaginated vesicle of columnar cells closely applied to the sides of the medulla. The medulla posterior to the auditory sac rounds up rapidly into the tubular nerve cord which is well developed and prominent in this stage and continues to the tail region. There, the nerve cord fades out into a caudal mass which is losing its embryonic character.

The process of vacuolation of the cells of the notochord which began

in Stages 128 and 144 has progressed and now is evident throughout its length. The cells as a result of this process have been greatly enlarged and the notochord has been increased in diameter. The notochord acquired its maximum length in Stage 128. It extends forward to end beneath the medulla, approximately at the anterior end of the pharynx. The anterior end of the notochord from this time on appears to be a relatively fixed point, with respect to the floor of the medulla, but the relative positions of the anterior end of the pharynx and of the infundibulum become greatly altered as development proceeds

The foregut terminates at a point posterior to the orbit, and in contact with the underlying surface of the head region. Neither in this stage nor subsequently is there any indication of the presence of a stomodaeum. The end of the foregut is some 100 microns behind the posterior end of the infundibulum, but in later stages, these two structures come in contact with each other.

The foregut is completely folded on itself. It arches broadly laterally, and extends to the surface ectoderm. The branchial furrow is essentially an infolded portion of thickened ectoderm in the angle on the side of the head. The hyomandibular pouch is in contact with this furrow but no cleft is formed. The first branchial pouch beneath the anterior portion of the auditory sac has broken through this furrow to form an open gill cleft, in which the pharyngeal wall is continuous with the surface ectoderm The ectoderm lines the outer end of the cleft for a comparatively short distance, leaving the remainder of the cleft lined by entoderm. A few sections posterior to the first branchial cleft, the second branchial pouch appears for the first time and extends laterally to come into contact with the lateral ectodermal plate for a short distance.

The pharynx itself does not possess a lumen, but as it rounds up into the esophagus, just behind the second branchial pouch, a lumen appears in the future gastric region. The gut at this stage is in the form of a closed tube throughout its entire length, lined with columnar epithelium. Its lumen gradually diminishes in diameter posteriorly. At the level of the 36th and 37th somites, the tubular gut terminates in a loosely organized strand of entodermal cells which marks the location of the future anus. Beyond that point, the entoderm continues as a solid strand of cells, the post-anal gut. This soon loses its identity, along with the notochord in the remains of the primitive streak. The post-anal gut overarches Kupffer's vesicle which now lacks a cellular floor above the yolk.

The heart has developed progressively beyond the condition described in the previous stage. The endocardium is clearly separated from the lateral epi-myocardial layers, and forms a single straight tube which extends beneath the anterior end of the pharynx from its anterior end to the level of the first branchial cleft. Here it bifurcates into two vitelline veins which spread laterally over the surface of the yolk. Paired dorsal aortae appear above the hymandibular pouch and extend backward to fuse in the midline beneath the notochord just beyond the level of the second branchial pouch. The single dorsal aorta may be traced from this point backward to the level of the eighth somite.

More caudally, its outline is lost in the undifferentiated intermediate cell mass in the median line from which it arises.

In order to avoid complexity no attempt was made to place either the somites or the pronephric tubules and ducts on the reconstruction drawing of this stage. The somites number 39 pairs, and extend from just posterior to the auditory sac, as before, throughout the body, to a point opposite the anterior end of Kupffer's vesicle. Behind the last somite, the mesoderm continues as an undivided mesodermal mass, which terminates in the primitive streak. The myotomes of the first anterior six somites possess myofibrils. The pronephric chamber possesses a distinct cavity opposite the fifth somite. The pronephric ducts extend backward to the anal region, and possess a lumen in their anterior portion. The pronephros is probably functional from this time to hatching.

The tail region is seem to be distinctly raised off the surface of the yolk, and to be rimmed in the median line by a continuous fin fold.

DEVELOPMENTS OCCURRING BETWEEN STAGES 228 AND 400

Stage 272. O. S. U. Series.—(Incubation period, 46 days, 4 hours; 133.78 T. U.; 49 somites.) The liver appears for the first time in this stage. It is a ventral evagination from the mid-gut, at the level of the sixth somite.

Stage 288. O. S. U. Series.—(Incubation period, 48 days, 16 hours; 136.44 T. U.; 52 somites.) The pre-auditory or branchial sense organ placode is now separated from and independent of the auditory vesicle. The 3rd and 4th branchial pouches are present in succession behind the branchial cleft. Myofibrils have formed in the somites throughout the middle of the trunk. In this same region the dorsal aorta is conspicuous, but devoid of blood cells. Below it lies a large intermediate mass of cells which constitute blood islands. From this mass the axial vein and the erythrocytes of the embryonic blood supply become differentiated. The embryonic coelom is conspicuous also at this level. The gut is surrounded by splanchnopleural folds and it is suspended by a dorsal mesentery.

Stage 304. (Incubation period, 51 days, 12 hours; 139.1 T. U.; 56 somites.) At this stage the pectoral fins appear as lateral masses of undifferentiated mesenchymatous tissue, covered by a thin layer of squamous epithelium. They are small, rounded, lobate structures extending laterally from the body just posterior to the head region. Their faint outlines in surface views of whole mounts are seen at this stage with difficulty, but by Stage 400 they are clearly visible. They apparently arise as outgrowths from the body wall, with which they are closely associated, rather than from the head mesoblast as described by Wilson in *Serranus.*

Stage 320. (Incubation period, 54 days, 4 hours; 141.76 T. U.; 62 somites.) For the last several stages described, the cells in the anterior portion of the notochord have been undergoing vacuolation progressively caudad. As a result, the protoplasm of the notochordal cells in the anterior half of the embryo has been reduced to a thin peripheral layer. For the first time in the present stage, the notochord

is surrounded by a hyaline sheath which takes a deeper stain than the surrounding tissue. From this incipient condition, this hyaline cartilaginous sheath becomes increasingly thick and more rigid as development proceeds. Beneath the notochord, the dorsal aorta may be traced throughout the length of the body into the tail region, where the caudal vein runs beneath it. The subintestinal vein is visible beneath the intestine for the first time. The gut possesses a distinct lumen throughout its length. The splanchnopleural folds, which were seen to surround the mucosal layer of the primitive gut wall in Stage 288, have apparently split into a double layered condition. These two layers constitute the primordia of the muscular wall of the intestine and its peritoneal covering. Posteriorly, the gut penetrates the ventral fin-fold of the body wall and ends at its lower margin. The vent is virtually closed. A few sections in advance of it the pronephric ducts unite and enter the dorsal wall of the gut at a point which represents the roof of the cloaca.

The fin-fold around the tail is composed of a folded layer of epidermis. Interrupted at the vent, it continues forward as far as the body is free from the yolk.

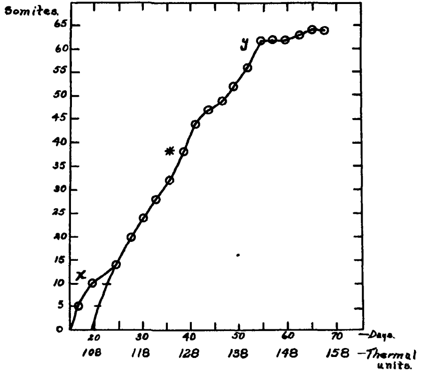
Stage 352. (Incubation period, 59 days, 12 hours; 147.08 T. U.; 62 somites.) The pronephric chambers on either side at the level of the 4th and 5th somites have become enlarged and have migrated farther than previously toward the midline. Their mesial surfaces are infolded and enclose short branches of the dorsal aorta to form a simple glomerulus. The chamber ends in a blind sac at the level of the sixth somite.

Stage 368. (Incubation period, 62 days, 4 hours; 149.74 T. U.; 64 somites.) With this stage, the full adult number of somites is present in the embryo. At no time in the remaining stages of this series has a greater number of somites been found. The number, then, of sixty-four somites may be regarded as the hatching number, and the definitive number for this species. It is of interest to note that the complete number of somites is differentiated in the whitefish before the embryo has completed the first half of its incubation period.

Once the formation of the paired somites is initiated, an increase in their number apparently occurs at a rate directly proportional to the number of thermal units to which the embryo has been subjected. In the foregoing descriptions, the length of the incubation period of each stage in this series is given in terms of both time and thermal units following fertilization. It is seen from these data that at Stage 112, no paired somites were present. By Stage 120, five somites were present and the sixth was partly formed. This embryo had undergone 105 thermal units of incubation.

The complete number of somites was acquired when the embryo had been subjected to an incubation period of 150 Thermal units. When the numbers of somites for the different stages through this part of the embryonic period are plotted on a graph as ordinants and the thermal units of incubation for these same stages are plotted as abscissae, the resulting values form practically a straight line curve. (See Graph No. 1.) This may be interpreted as expressing a direct

relationship between these two sets of factors, the number of somites increasing at a rate directly proportional to the sum of the time and temperatures to which the embryo has been exposed. The thermal units have been calculated from daily temperature and time charts of the incubation period, following the method described in the first paper of this series. If the thermal unit is a valid criterion for deter-



GRAPH No 1. The relation between the age of the whitefish embryo, expressed in terms of days and thermal units of incubation, and the number of somites present. The small circles indicate thermal unit values The symbol x indicates the period of initial somite formation; the asterisk, *, the stage when the heart and pronephric tubules becomes established, the symbol y, the appearance of definitive axial blood vessels.

mining comparable stages in different series of embryos, then embryos of the same age in number of thermal units will have a similar number of somites.

The curve is actually not straight but rather a wavy line. There are three periods in which the growth increment is greater than in intermediate ones. The first, indicated by the letter x, on the graph, is an initial period of rapid growth, when the first few somites are being laid down. Then the rate is gradually retarded up to about 125 Thermal

units of incubation. A second period (*) of more rapid growth is then initiated. It is of interest to note that at this time two significant events occur. The heart is formed as a distinct tube, but devoid of blood cells, and the pronephric ducts for the first time acquire their lumen, and extend to the anus. Both the circulatory and excretory systems probably begin to function at this time. The probability that these systems influence the growth rate of the somites is strengthened by the fact that in the amniotes the growth rate of the embryo is influenced by them in a similar manner (Schmalhausen, 1927). The third cresty in the curve occurs just after the dorsal aorta and the axial vein become distinguishable throughout the length of the embryo, and are filled with blood.

The curve now bends rapidly to the right The formation of additional somites is here apparently greatly retarded by inhibiting factors which operate to prevent the formation of more than sixty-four somites in this species. The embryo hereafter possesses this same number of somites. The curve for these later stages then would be a straight line.

The author is unable to say just how typical this curve with its fluctuations is for the species as a whole. The number of embryos included in this study is too few to warrant the deduction of very definite conclusions. Several embryos for each stage must be examined to determine the degree of variation within each stage before the relationship between these various factors may be stated with any degree of certainty.

In the myotomal region of the anterior somites the myofibrils have a beaded appearance, due to the presence of alternate light and dark bands. These collectively, of course, give the appearance of cross-striations to these fibres.

Stage 400. (Incubation period, 67 days, 12 hours; total length of embryo, 8 mm.; 64 pairs of somites; 155.06 T. U.) (Reconstruction drawings, Plate IV.)

Despite the fact that the embryo at this stage has only completed one-half of its incubation period, it has now acquired two-thirds of its length at hatching (12 mm.) and the complete number of somites which it will possess at that time—sixty-four.

The embryo has been forced by the constant shrinking of the yolk sac to assume a curled position upon it. The tail which was becoming free from the yolk in Stage 224 (Plate III) has now become bent back on the body to form an almost complete circle on the surface of the yolk at this stage. This condition makes it impossible to reconstruct the embryo on a plane surface drawing in the coiled portions of the body. To do so would necessitate a drawing of one part of the coil seen behind or through the other, or viewed at an angle, which latter would introduce errors in perspective. It was found to be impossible to straighten the embryo from its curved position. Hence simply the anterior portion of the body, back to the first sharp curve, has been included in these drawings.

By a comparison of Stage 400 with Stage 224, it is seen that several noteworthy changes have occurred. During this interval the embryo has approximately doubled its total length, from 4.2 mm. to 8 mm. There has

been a great lateral growth of the body, especially in the head region. The depth of the head in the two stages is about the same; but seen from the dorsal surface (not shown in the drawings) the body and head, including the brain, have greatly expanded laterally. The medulla in Stage 400, *side view, appears thinner and more shallow than in Stage* 224. This is actually the case, but the thinning process is brought about by a lateral growth of the medulla which has approximately doubled its former width. The cavity of the fourth ventricle above it has also greatly expanded, and the membranous choroid plexus is a prominent landmark. There has been a correspondingly great lateral growth of the midbrain, and the differentiation of the metencephalon. The latter is now a thin transverse plate separated from the mesencephalon by a transverse fissure.

In Stage 224, the nasal pit is terminal on the forebrain. In Stage 400, there has been a downward and backward growth of the forebrain and the infundibulum, carrying the nasal pit with it until it comes to lie ventrally.

The expansion of the lobes of the brain, and their further differentiation into their definitive parts, has brought about a thinning of their walls, leaving cavities within. In Stage 224 no expanded cavities traceable in a drawing were present. As a result of the backward and under growth of the forebrain, the infundibulum is very prominent, and extends to a point in close proximity to the anterior end of the fore-gut. This growth has also carried the eye with it in its backward migration with the result that the eye and the ear are in much closer proximity to each other than formerly. It will be seen that the changed position must be due to the shifting of the forebrain, since the relative position of the ear to the medulla and to the anterior end of the notochord remains essentially the same as in Stage 224.

The foregut ends in the same relative position as in the latter stage. There is no visible connection seen between the foregut and the infundibulum, nor any semblance of a stomodaeum present.

The branchial pouches are broadly extended laterally. The hyomandibular pouch is more restricted in extent than in earlier stages. The first branchial cleft is the only one open at this stage. Branchial pouches II, III, IV, all lie posterior to the otic vesicle. They are separated from each other by an undifferentiated mass of head mesoderm which comprises the visceral arch. The pharynx has grown very broad here in comparison with the condition shown on the previous drawing, Stage 224, Plate III, in correlation with the lateral growth of the head. From the drawing of the median sagittal section, it is seen that there is no lumen present in the pharynx, and that it does not appear anterior to the gastric region, which is an expanded area at the level of the pectoral fin. Here the columnar epithelium is well differentiated. Surrounding this part of the gut, the liver is forming as an elongated glandular outgrowth closely applied to the rounded gut wall.

The tubular heart is considerably larger than in Stage 224. It has become elongated and now extends backward to the level of the esophagus, and bends in a U-shaped loop away from the median line. Only the two ends of the loop pass across the median line. The

heart is now suspended by the mesocardium within the pericardial cavity. The vitelline veins are large and are filled with erythrocytes. The short ventral aorta leads forward from the heart into the aortic arches which pass laterally over the pharyngeal folds.

The auditory vesicle is gradually undergoing differentiation. Its outline is no longer smoothly circular, but somewhat irregular, indicating three bulbous prominences, which will develop later into the ampullae at the bases of the semicircular canals.

The preauditory sensory placode was described in Stage 288 as having separated from the auditory vesicle but lying immediately anterior to it. Since that stage, this placode has apparently migrated forward. It now lies on the side of the head dorsal to the posterior curvature of the orbit and anterior to the level of the hyomandibular pouch. It is a single, elongated sensory patch. Its cells have become elongated and somewhat clustered.

The first anterior pair of somites lies immediately behind the auditory vesicle. These 64 pairs of somites are clearly seen in the whole mounts. Their cells are differentiated and contain striated myofibrils Beginning with the fifth or sixth pair, each somite has been divided by a horizontal constriction into a dorsal and lateral portion. These muscle masses are probably capable of contraction to cause bodily movements

The pronephric chambers each have a single glomerulus on their mesial border, and the pronephric tubules enter the dorsal portion of the cloaca as described in Stages 320 and 352.

The paired pectoral fins which were previously described as first appearing in Stage 304 are now definitely raised up from the surface of the lateral somatopleure and possess a median longitudinal fin fold. They are subtriangular in shape and lie opposite somites III to VII.

SUMMARY

This paper is the second of a series of three papers on the embryology of the whitefish. The author's purpose is to locate the incipient stages in the development of each of the organ systems and to trace their general development in this particular series of embryos

It is seen from the descriptions of Stages embodied in this paper that every line of development in the whitefish embryo is well established by Stage 30, which marks the end of the first half of the incubation period of this series in terms of time and temperature under normal hatchery conditions

Since the closure of the blastopore, differentiation and growth have converted the primitive embryo into one of distinct fish-like form. It is now completely coiled on the yolk, and is two-thirds its hatching length. The tri-lobed brain has developed its definitive regions, and the nose, eye and ear are advanced well beyond the vesicular condition.

The differentiation of the organs derived from the mesoderm scarcely begins before the closure of the blastopore The growth of the notochord forward, the vacuolation of its cells, and its investment by a cartilaginous sheath has been traced. The increase in the number of somites to the full number, and the differentiation within the muscle masses of striated myofibrils has been described. The development

of the heart, axial blood vessels, and definitive blood cells has brought the circulatory system up to a stage where it is probably functional. The same is true of the pronephric kidneys which are seen to develop concurrently. The visceral arches, pericardium and the coelomic cavity are all well established.

The entoderm comprised an unfolded primary germ layer at the time the blastopore closed. Since that stage, the gut has become a closed tube throughout its length. The first of the branchial pouches has broken through the pharyngeal wall to form a cleft and the remaining three pouches are well defined. The liver and the lumen of the gastric region have developed. The anus has not ruptured through the ventral fin fold.

The primitive streak, so prominent when the blastopore closed, has gradually shortened, and its substance has contributed to the formation of structures in the tail region. Kupffer's vesicle, formerly so prominent, has disappeared in the region of the anus.

Thus the period of organogenesis closes. Before the embryo may emerge from its egg shell, growth and further differentiation must bring it to the hatching state. The outstanding phases in this later development of the whitefish will be discussed in the paper which is to follow.

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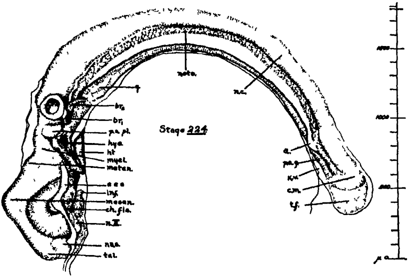
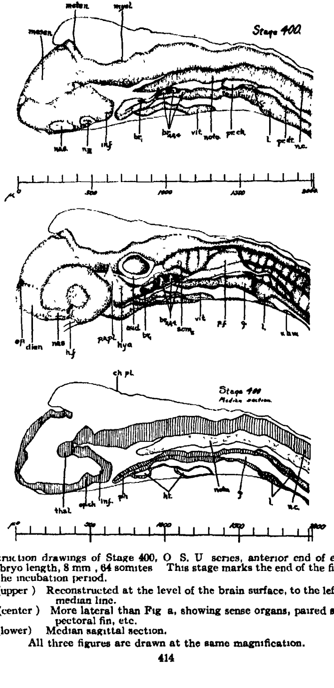
ABBREVIATIONS USED IN PLATES III AND IV

a	anal region	meten	metencephalon
aud	auditory vesicle	myel	myelencephalon
br. 1	first branchial cleft	n. II	optic nerve
br 2, 3, 4.	branchial pouches	nas	nasal pouch
ch fis	choroid fissure	n. c	nerve cord
ch pl	choroid plexus	noto	notochord
c m	caudal mass, or primitive streak	op. ch	optic chiasma
		p a. g	post-anal gut
dien	diencephalon	p. f	pectoral fin
e e. s	extra-embryonic somatopleure	ph	pharynx
ep	epiphysis	p a. pl	preauditory placode
g	gut	pr. ch	pronephric chamber
h. f	head fold	pr. dt	pronephric duct
ht	heart	som. I	first ant. somite
hyo	hyomandibular pouch	tel	telencephalon
inf	infundibulum	t. f	tail fold
K v	Kupffer's vesicle	thal	thalamus
l	liver	v b. w	ventral body wall
mesen	mesencephalon	vit.	vitelline vein



Reconstruction drawing of Stage 224, O. S U. series, in natural position over the yolk. Length of embryo, 4.2 mm.; 39 somites.



Reconstruction drawings of Stage 400, O. S. U. series, anterior end of embryo. Embryo length, 8 mm., 64 somites. This stage marks the end of the first half of the incubation period.

Fig. a (upper.) Reconstructed at the level of the brain surface, to the left of the median line.

Fig. b (center.) More lateral than Fig. a, showing sense organs, paired somites, pectoral fin, etc.

Fig. c (lower) Median sagittal section.

All three figures are drawn at the same magnification.

A PRELIMINARY STUDY OF THE LENGTHS OF THE OPEN VESSELS IN THE BRANCHES OF THE AMERICAN ELM[1]

FRANKLIN G. LIMING

Results obtained from previous studies by the writer, using basic dyes and the spores of *Graphium ulmi* (the fungus causing the Dutch Elm Disease) in elm branches, and other workers, using mercury and various dyes in apple, oak and other woody stems, indicate that in a given species the length of the vessels in young stems is less than in older stems and that in stems of the same age there is a close correlation between the length of the vessels and the length of the stems in which they occur. As a preliminary study of the development of the water conducting system of the American elm (*Ulmus americana* L.) about 1,100 vessels in branches of different ages and lengths were measured to ascertain the relationship which exists between the length of the vessels and the age and length of the branches in which they were located.

The branches used in this study were taken from the upper part of the crowns of young elm trees during the month of February, 1932. The trees were about 11 m. high and about 15 cm. in diameter 1 m. from the ground. Only those branches which had made what appeared to be a "normal" growth in length during the last four years were used. Owing to the fact that the length of the terminal growth on the same branch varies from year to year and on different branches within the same year the length of the portion of the branch to be used was determined by yearly segments and parts of yearly segments rather than by definite fixed lengths

In making the determinations the basal ends of branches of the desired age were cut square across with a sharp knife and connected to the lower end of a mercury column by means of a piece of "high pressure" rubber tubing. An arbitrary height of 120 cm. of mercury was chosen as a source of pressure Mercury under this pressure will pass through any unobstructed opening over 1.3 μ in diameter with which it comes in contact. The lumina of the water conducting vessels in elm branches are

[1]Papers from the Department of Botany, The Ohio State University, No. 348.

well over 1.3 μ in diameter. With the cut end of the branch in contact with the mercury and the rest of the branch held in a horizontal position, pieces about 0.5 cm. long were cut successively from the unattached end of the branch until the mercury was observed to pass through the remaining portion of the branch in one vessel. The high surface tension of the mercury causes it to take the form of small spherical droplets as it first emerges from the branch, thus making its presence and exact location easily determined. The fact that the mercury passes through the branch indicates that there is one opening 1.3 μ or more in diameter extending the entire length of the remaining portion of the branch. Since the mercury does not pass through the branch before the last piece is cut off the opening must terminate in that section. Therefore the vessel either terminates at an end wall in that section or is plugged by some mechanical obstruction such as tyloses, gums, etc. Just how far the vessel or opening being measured extends below the point at which the mercury was attached can not be determined. Thus it is evident that the measurements obtained by the above method do not necessarily represent the full length of the vessel but only the length of the branch from the point of attachment through which there is a continuous opening 1.3 μ or more in diameter. The term "open vessel" as used in this paper refers to such openings. After the longest open vessel in a branch was measured the length of other open vessels in the same branch was ascertained by cutting off additional pieces, watching for the appearance of other mercury droplets, and then measuring the length of the portion of the branch through which the mercury passed in the other vessels.

The longest 15 vessels in all the branches were located in the outside annual ring. When the branches were cut back to such a length that the mercury passed through them in the vessels in the inner annual rings the amount of mercury coming through the open vessels in the outer annual ring was so great that it was impossible to determine the exact number of vessels through which the mercury was passing in the inner annual rings. The passage of mercury through the vessels in the outer ring was avoided by disconnecting each branch from the mercury column after the vessels in the outer ring had been measured and carefully removing the wood of the outer annual ring of each branch at the basal end so that when the branch was

again connected to the mercury column the vessels in the outer annual ring were not in contact with the mercury. With the branch connected in this way the length of the open vessels in the inner annual rings was measured. In no instance was the mercury observed to pass from the vessels in any one annual ring to the vessels in any adjacent annual ring. This indicates that there were no openings 1.3 μ or more in diameter connecting the open vessels in any two annual rings.

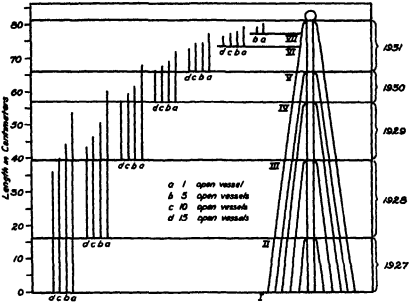


FIG. 1. The average length of the last five yearly segments of the branches of American elm and the average length of the longest portion of the branches through which mercury passed in 1, 5, 10 and 15 open vessels in the spring wood of the 1931 annual ring from the points I, II, III, IV, V, VI and VII.

The above method is suitable only for branches less than 3 cm. in diameter. The larger branches used in this study were connected to the mercury column with an "injection jet" designed by The Davey Tree Expert Co. In this way the mercury is introduced into the branch through a hole bored into the side of the branch instead of at the basal end as in the smaller branches. Instead of the small 0.5 cm. pieces, sections 5 to 10 cm. long were cut from the end of each branch until the mercury passed through the remaining portion of the branch.

Figure 1 represents diagramatically the average length of

the last five yearly segments of the branches used and the average length of the measured open vessels in the spring wood of the 1931 annual ring in these segments. Mercury was applied at the points I, II, III, IV, V, VI, and VII in the various branches and forced towards the terminal end of each branch. The length of the portion of the branch and the number of vessels in which mercury would pass through the branch was found to be the same regardless of which end of the branches was attached to the mercury. The lines a, b, c, and d represent the average length of the branches through which the mercury passed in 1, 5, 10, and 15 vessels respectively from the point of attachment.

The open vessels measured in this study ranged in length from 0.5 cm. to 5.5 m. The shortest open vessels measured were located just below the terminal buds and the longest open vessels were located in the spring wood of the 1931 annual ring in the lower part of the trunks.

There is a very definite and consistent correlation between the length of the open vessels in the spring wood of the 1931 annual ring and the length and age of the branch in which they are located. In general the length of the longest portion of the branch having five open vessels extending through it is about 55% of the total length of the branch. The length of the open vessels is more closely correlated with the length of the branch, and with the age of the branch in so far as it affects the length of the branch, than with the age alone. For example, the open vessels in branches of the same age and length were found to be about the same length while those in other branches of twice the age and double the length were found to be about twice as long. However, if the branches were all the same age and some of them were twice as long as the others the vessels in the longer branches were not twice as long as those in the shorter branches but only about 90% to 95% longer. Also, if the branches were all the same length and some of them were one year older than the others the vessels in the older branches were found to be from 5% to 10% longer than the vessels in the younger branches.

In the inner annual rings, the vessels or openings through which the mercury passed were limited largely to the summer wood of each ring and were only from 5% to 10% as long as those in the spring wood of the outside ring in the corresponding segment of the same branch. Microscopic examination showed

that there were many tyloses present in the spring vessels in these inner annual rings. The actual length of the vessels in the spring wood of the inner annual rings may be the same as those in the outside ring of the corresponding segment, but the passage of mercury was prevented in some way, probably by the presence of tyloses, gums or other mechanical obstructions. The fact that mercury fails to flow for more than short distances through the vessels of these inner annual rings does not, of course, necessarily mean that the movement of water through such vessels is similarly restricted. A more detailed study dealing with the structure and time of formation of these obstructions is now in progress.

SUMMARY

1. The length of 1,100 open vessels in American elm branches of different lengths and ages was ascertained by forcing mercury through the branches under a pressure of 120 cm of mercury.

2. There was found to be a close correlation between the lengths of the open vessels in the spring wood of the 1931 annual ring and the lengths of the branches in which they were located. The length of the longest five open vessels extending through the branches, from any point on the branch, towards the terminal end was found to be about 55% of the distance of that point from the terminal end of the branch.

3. There was also a close correlation between the age of the branches and the length of the vessels in them. This correlation was found to be largely due, not directly to age alone, but to the increase in length of the branches resulting from the increase in the age of the branches

4. There was no evidence that the mercury passed from the vessels in any one annual ring to the vessels in any other annual ring.

5. In the inner annual rings, the vessels or openings through which the mercury passed were limited largely to the summer wood of each ring and were only from 5% to 10% as long as those in the corresponding segment in the 1931 annual ring.

The writer wishes to acknowledge the assistance received from Dr. B. S. Meyer and Dr. W. H. Camp, of the Department of Botany, Ohio State University, and Dr. O. N. Liming, of the Dutch Elm Disease Control Office, U. S. D. A., and to thank the Davey Tree Expert Co. for the use of certain apparatus used during the course of the study.

NOTES ON ZYGNEMATACEAE[1]

E. N. TRANSEAU

Further study of certain groups of species of the *Zygnemataceae* has suggested the desirability of raising several previously recognized varieties to the status of species, as follows:

Zygnema ornatum (Li) comb. nov.
(= *Z. collinsianum* Transeau var. *ornatum* Li, 1933).
Not uncommon in the states from Alabama to Oklahoma.

Spirogyra suecica nom. nov.
(= *S. varians* (Hass.) Kuetz. var. *gracilis* Borge, 1923).
Known in the United States from Iowa, Ohio and Florida.

Spirogyra labyrinthica nom. nov.
(= *S. daedalea* Lagerheim var. *major* Hirn, 1913).

Spirogrya distenta nom. nov.
(= *S. decimina* (Mull.) Kuetz. var. *inflata* Fritsch, 1921).
Known in the United States from Illinois and Ohio.

Spirogrya discreta nom. nov.
(= *S. inflata* (Vauch.) Rab. var. *foveolata* Transeau, 1914, which is not a synonym of *S. foveolata* Czurda, 1932).

Spirogyra teodoresci nom. nov.
(= *S. varians* (Hass.) Kuetz. var. *minor* Teodorescu, 1908).
Widely distributed in the eastern United States.

Spirogyra suomiana nom. nov.
(= *S. punctata* Cleve var. *major* Hirn, 1895).

Spirogyra crassiuscula (W. & N.) comb. nov.
(= *S. maxima* (Hass.) Wittr. f. *megaspora crassiuscula*, W. & N. 746).
Diam. vegetative cells 145–170μ, spores 120–150μ × 85–100μ.

Spirogyra megaspora (W. & N.) comb. nov.
(= *S. maxima* (Hass.) Wittr. f. *megaspora crassa*, W. & N. 745).
Diam. vegetative cells 170–200μ, spores 135–170μ × 95–120μ.

Sirogonium tenuius (Nordstedt) comb. nov.
(= *Spirogyra sticica* (Eng. Bot.) Wille var. *tenuior* Nordst., 1882).
Originally described from the Argentine, and recently collected by C. E. Taft in Oklahoma.

[1]Papers from the Department of Botany of the Ohio State University, No. 347.

NOTES ON CERTAIN OHIO OAKS[1]

W. H. CAMP

Although the present study of the Ohio oaks is by no means complete, it is thought best to call attention to several features of the work at this time.

In the first place, certain corrections should be made in the nomenclature:

Quercus maxima (Marsh.) Ashe.—(*Q. rubra* L.)—Red Oak.
Quercus rubra L.—(*Q. tribola* Michx.)—Spanish Oak.
Quercus montana Willd.—(*Q. Prinus* L.)—Rock Chestnut Oak.
Quercus Prinus L.—(*Q. Michauxii* Nutt.)—Cow Oak.

Although the Cow Oak (*Q. Prinus*) is not certainly known to occur in Ohio it is here listed to indicate the disposition of that species. It is unfortunate that the above specific names, known so long and almost universally used, must be changed, but the shift is necessary to keep the nomenclature correct.

One of the problems in working with the oaks is the differentiation between certain species, and hybrids between other species or their aberrant forms. A case of this is a collection made by Dr. Kellerman in Gallia Co., in 1901, which he took for a hybrid (*Q. palustris* X *Q. velutina*). The present writer feels that this is not the case, rather, that it is an extremely aberrant form of the Scarlet Oak (*Q. coccinea* Muench.), although a careful examination of the specimen, together with Dr. Kellerman's field notes, seem to indicate that it is Hill's Oak (*Q. ellipsoidalis* E. J. Hill). This last species is not known farther east than northwestern Indiana.

Another case of this type is Schneck's Oak (*Q. Schneckii* Britt.). This species, typically southern in its distribution, but occurring fairly commonly along the Ohio River as far north as Indiana, is recorded for Ohio by Small (Man. S. E. Flora, 1933) and specifically for the Cincinnati area by Braun (Amer. Midland Nat., Vol. 15, p. 30, 1934). It is, however, represented in the O. S. U. Herbarium by only two collections, both of them from Franklin County. It is hoped that subsequent collecting in southern and southwestern Ohio will reveal intermediate stations, but until then it is doubtful if Schneck's Oak, in its true form, occurs in central Ohio.

Alexander's Oak (*Q. Alexanderi* Britt., Man. Fl. N. St. and Can., p. 336, 1901) has been recognized by Trelease as a form of the Chestnut or Yellow Oak (*Q. Muhlenbergii* f. *Alexanderi* Trel., Mem. Nat. Acad. Sci., Vol. 20, p. 111, 1924). Field studies in various areas where this species is common indicate that it has a definite genetic constitution and

[1]Papers from the Department of Botany, The Ohio State University, No. 349.

with its characteristic broadly obovate leaves should be considered a valid variety. The present writer therefore proposes the combination **Quercus Muhlenbergii** var. **Alexanderi.**

One of the most interesting features of the present work has been a special study of the Northern Red Oak—Gray Oak complex. If the Gray Oak (*Q. borealis* Michx. f.) is to be considered as separate from the Red Oak (*Q. maxima* (Marsh.) Ashe.) then it is not uncommon, being known from at least twelve counties, mainly within the eastern half of Ohio. It is, however, the opinion of the writer that the two are not distinct but only two extremes of the various possibilities within the genetic range of the species, in which case our ordinary Red Oak would return to the earlier name, *Q. borealis* var. *maxima* Sarg. A statistical study of the variations within this particular group will be considered in a later paper.

BOOK NOTICES

Heat

This is a book suitable for use in a two-year course in physics such as is given at Massachusetts Institute of Technology, and to be taken simultaneously with a course in differential and integral calculus The calculus is consequently used, at first in a small way, but gradually more and more, to treat the usual topics in statics, dynamics, and hydrodynamics

The reviewer feels that the M. I T is to be congratulated that they find it possible to give a course in general physics where such a book may be applicable. This is, however, not generally the case in American colleges and universities, and it would seem that the book would have a rather limited field of application.
—HAROLD H. NEILSEN

Introduction to Mechanics and Heat, by N H Frank; xiv + 339 pp. New York, the McGraw-Hill Book Co., 1934.

Abnormal Behavior and its Explanation

After a consideration of the question as to what constitutes abnormality, without a satisfactory answer, the authors discuss sensory and motor disorders, theories of a number of functions which they assemble under the head of the association mechanism, and finally desires, feelings and emotions, sleep, dreams and hypnosis. Thus the first two-thirds of the book is devoted to a discussion, often very sketchy, of common functions and the particular changes the physician often sees in them which follow trauma, shock, infection, etc. Two chapters treat the organic and functional psychoses and the remainder of the book consists of short chapters on the psychoneuroses, mental deficiency and superiority, and psychotherapy.

The authors have "written for advanced students in psychology, pre-medical and medical students who desire more psychological information" In a foreword Professor Knight Dunlap believes that this book "signalizes the beginning of the scientific era in abnormal psychology." There are indexes of subjects and authors and a bibliography of 313 titles.—S. RENSHAW.

Textbook of Abnormal Psychology, by R. M. Dorcus and G. W Shaffer; xii + 389 pp. Baltimore, The Williams and Wilkins Co., 1934.

Features in the Architecture of Physiological Function

The author takes the stand of those who regard a phenomenon as more likely to have a significance than not. He is willing to help take the burden of discovering what the significance may be. He admits the possibility of accidents in nature, but prefers to avoid the responsibility of proving all phenomena to be accidental.

As to the manner of describing one set of conditions prerequisite to new developments in physiological function, the distinction between a purely teleological attitude and one leading through descriptive analysis is drawn on the quotation, "The stage is set before the play commences."

The book is built on the Dunham Lectures given at Harvard in 1929 An easy, fluent atmosphere characterizes the presentation of the many physiological facts on which the book is constructed The physiological processes are discussed as following principles of function rather than proceeding from mere organ structure or chemical formulae The stability of the internal environment compels the principle of storage of materials and of integration in adaption This concept leads through the material of the chapters with the description of the parallel mechanisms that may function in integrative processes as well as in antagonistic responses —R. G SCHOTT.

The Architecture of Physiological Function, by Joseph Bancroft x + 368 pp. New Yowk: The MacMillan Company, Cambridge, England· at the University Press, 1934.

Entomological Equipment and Methods

In his new book, "A Manual of Entomological Equipment and Methods," Professor Peterson has done for the teacher and research worker what each has wanted to do for himself but for which he has had neither the time nor the necessary reference material It is a most excellent collection of diagrams of experimental equipment and apparatus used by entomological workers in every phase of the subject The diagrams are completely labelled and references are given to the sources. They are grouped in a system of classification based upon use such as: Insectaries; Cages; Collecting, Killing and Sampling, Traps; Behavior Equipment; Weather Recording Instruments, Thermocouples; Thermostats; Cabinets; Insecticide Testing; etc The plates are a bit crowded, but very clear and complete.

The manual also contains brief discussions, convenient conversion tables for temperature, humidity, weights and measures, and author and subject indexes. It is a book that no entomologist can afford to be without, being full of suggestions for methods of research and apparatus construction which with the references will save many days of tedious labor.

The work is lithoprinted, contains 138 plates and is durably bound in cloth.
—D F. MILLER

A Manual of Entomological Equipment and Methods, by Alva Peterson. Ann Arbor, Michigan: Edwards Brothers, 1934. $3 75.

Theoretical Physics

This book may unambiguously be termed one of the most enjoyable publications by McGraw-Hill in their International Series It contains brief, yet complete accounts of the most important problems in theoretical physics, emphasizing those items in classical physics which lead directly to the modern quantum aspects. The first two chapters concern themselves about the mathematical equipment necessary to cope with physical problems; fifteen chapters are devoted to problems in analytical mechanics and hydrodynamics. Eleven chapters are given to discussions of heat flow, potential theory, electromagnetic phenomena and optics while the remaining fifteen chapters concern themselves with atomic and quantum phenomena.

In addition to a clear exposition of the subject matter, a set of problems supplements each chapter, a feature whose value cannot well be overestimated.

Like other books in this series, it is durably bound in green cloth and printed in large clear type It is a book sincerely to be recommended for use in college classes and is an asset to any physicist's library —HAROLD H NIELSEN

Introduction to Theoretical Physics, by J C Slater and N H Frank New York the McGraw-Hill Book Co 1933

Physics and Geology

This interesting manual which follows Snyder s Earth History consists of 20 exercises the first eleven covering Physical Geology while the last nine cover Historical Geology Each exercise is accompanied by suitable blank pages which are intended to be removed and when graded returned to the manual and bound (suitable holes being provided) There are 91 exercise sheets and four cross-section sheets all numbered and punched for replacing The rest of the book is made up of explanatory text and assignments for completing the exercises

It is refreshing to pick up a laboratory manual which uses the most recent as well as the older topographic and geologic maps carefully selecting those which best exemplify the case to be studied It is a pleasure to recommend this manual to teachers of geology How widely used it will become remains to be seen Many teachers have wisely tried to take advantage of local areas for these laboratory stud es but needless to say good examples of the various areas are not available locally in most cases To the student it is a convenient and satisfactory method of procedure The authors have done a careful piece of work and the publishers have been equally careful We hope it meets with success but wish it could be sold for half the price —WILLARD BERRY

A Laboratory Manual of Physical and Historical Geology by Kirtley F Mather and C J Roy xiv + 302 pp New York D Appleton-Century Co 1934

Bone Infections

Here is a book of value not merely for the orthopedic surgeon but for the general practitioner and the student of pathology as well After years of practical experience in clinical and laboratory work and much delving into contemporary and historical literature Dr Wilensky has prepared a general and thoroughgoing monograph upon the subject No one interested in the field can afford to overlook this work

Although the introduction is unnecessarily pedantic it is a part of a well planned historical approach The early chapters build a broad background of normal anatomy and physiology upon which foundation the pathogenesis and symptomology of osteomyelitis are developed Considerable space is devoted to treatment In this respect the author has without bias quoted freely from many sources giving varied points of view in addition to his own and citing numerous case experiences to advantage

The book is very comprehensive and written in a clear scholarly style It is adequately illustrated with diagrams normal photographs X-ray photographs and microphotographs and contains an abundance of tabulated data Other outstanding features are the inclusion of an extensive bibliography covering all phases of the subject classified and distributed by chapters and author and subject indexes —D F M

Osteomyelitis—Its Pathogenesis Symptomology and Treatment by A O Wilensky xxxii+454 pages New York The Macmillan Company 1934. $9 00

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